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A composite picture of the New Zealand dairy industry — its organization and principal products — is presented in the articles which follow. This material was first published in the "New Zealand Journal of Dairy Science and Technology", Volume 5, No. 3, 1970, and is reproduced here by courtesy of the New Zealand Society of Dairy Science and Technology.

Reprinted by New Zealand Dairy Research Institute, P.O. Box 1204, Palmerston North,
New Zealand.

Publication No. 529.

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THE ORGANIZATION OF THE NEW ZEALAND DAIRY INDUSTRY

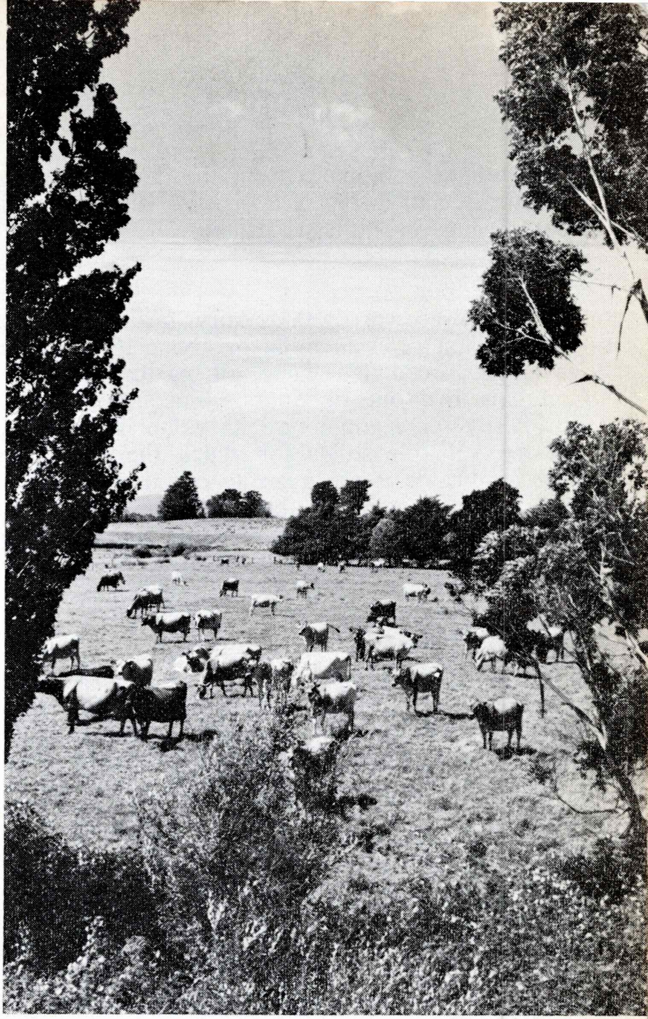
By C. PATRICK
*New Zealand Dairy Board, Wellington,
New Zealand*

Origins

The New Zealand dairy industry is distinguished from others by the fact that it arose from and continues to exist primarily for external trade, and by the fact that the export of manufactured dairy products is one of New Zealand's basic industries.

Because there is no place for a middle-man between the production of milk and its processing, there is a world-wide tendency to co-operative processing, but in New Zealand this has probably been carried furthest, and practically all basic dairy manufacturing is in the hands of producer co-operatives. The co-operatives pay no dividends, and distribute their earnings entirely on the basis of the quantities of milk or cream supplied; they generate capital funds from earnings or borrow from outside sources as each company may choose. It is significant that the co-operatives require the involvement to an important degree of their supplying shareholders, who elect the directorate. It is also significant that the usual form of land tenure in New Zealand is freehold (subject to mortgage) whereby earning power, including the strength of the adjacent co-operative dairy companies, can be reflected in land values, as are the relative rewards obtainable from alternative land use.

To review the organization of the dairy industry it is necessary to note its origins. Passing over the subsistence dairying of the early New Zealand settlements, the beginning of today's industry is usually put at 1882, when the first refrigerated shipments of meat and dairy produce left for the United Kingdom. Here is illustrated the colonial nature of the trade: the ship was British; the destination was the United Kingdom whose cheap imported food policy was (and still is) so important; the products were butter and cheese, for which markets already existed in the United Kingdom; they were made by imported processes; the trade, and in most cases the factories themselves were financed largely by London merchants.



A typical New Zealand dairying scene.

From the start, the producers sought to get a grip on their own affairs. This has brought the domination of the industry by the co-operatives; combination for services such as cool storage, transport and the purchase of manufacturing requisites; further combination and risk-sharing in export trading, which has led to the New Zealand Dairy Board of today; and, more recently, endeavours to influence positively the external trading environment, which is to say to take part in the great political debate on international trade and development. The theory of international trade which is almost universally advocated as a principle, but not so widely practised, is based on principles of comparative advantage in economic affairs. The dairy farming industry of New Zealand is an outstanding example of the type of enterprise which should, according to these principles, flourish.

Structure

The urge to combine for export trading is apparent in the earliest records of the industry but, while some earlier attempts were made, the organization which now trades as the New Zealand Dairy Board dates effectively from the year 1936. In the 34 years of uninterrupted trading which have followed there have been many developments in commercial techniques, diversity of products and markets, in the development of resources, and in policy formation, but no significant change in the basic structure.

Milk Production

On upward of 20,000 dairy farms are over two million cows in milk, or about 100 each on average. Feed is nearly all pasture and the animals live out of doors. Since the milk is primarily for manufacture its value is contained in the valuable solids for which the commonly used indicator is the quantity of milkfat. Typically, milk containing about 300 pounds of fat per cow per year is supplied to the manufacturing units. Total solids are typically 13-13½% (of which fat is about 4.8%).

Factory Supply

As a rule, producers are free to choose which co-operative dairy company they will supply. Consequently the relative earning power of neighbouring companies is a competitive factor which accounts for much of the internal efficiency of operation of the factories and for the ready response which dairy companies make to the needs of export markets as expressed in the Dairy Board's buying programmes and incentives.

Fluid Milk Market

The processing and distribution of 'town milk' is separately organized, and will not be discussed here, except to note that this outlet provides for less than one-tenth of total milk produced.

Local Market

The dominance of export is demonstrated by the figures for local sales which, for butter are 50,000 tons out of a total of over 250,000, for cheese 11,000 out of 100,000, for milk powders about 10% and for casein less than one percent of the total. Local butter distribution is rationalized by a system of regional, but sometimes overlapping, distribution licences; but other products are traded without even this measure of guidance.

An unusual view of the world's largest powder factory — the Te Rapa Branch of the New Zealand Dairy Company, Hamilton.

Manufacturing

There are now about 100 dairy companies in New Zealand. About 900 tankers collecting milk for manufacture become in effect mobile pipelines from the holding vats at farm dairies — taken together the tankers and the vats add several million gallons of capacity for the milk flow. The ability of the industry to deploy milk between plants, processes, and companies as market needs dictate has been dramatically increased as a result. Areas of milk supply are well concentrated, and the factories in turn are by most standards large. For example, the daily capacity of typical butter/casein or butter/powder units is commonly around 100,000 Imp. gal (450,000 litres) and some have three times that capacity. The companies decide which products to make, and are not subject to direction by the Board or anyone else except as to quality, hygiene, and labelling. The Board, however, is for practical purposes the market, so far as export products are concerned.

Export Trading

The Dairy Board proper comprises 11 members elected by the co-operative dairy companies and two Government nominees; it has a staff of over 400, and several subsidiaries and associated companies. The Board is required to purchase all butter and cheese tendered to it for export; it has permissive powers to acquire other products, which it exercises under the industry's policy for such major product groups as milk powders and casein, and it has general responsibility for any other export products. Since the Board does not direct manufacturing decisions, it must rely on purchase prices and on the provision of market information, advice, and incentives to bring about the pattern of purchases and hence of milk use which it desires in order to fulfil its responsibility to maximize returns from milk.

★ The Board's export purchases are financed by overdraft against the security of its stocks of products, and any surplus or deficit on annual trading is transferred to the Dairy Industry Reserve Account which acts as a buffer between the industry and short-term external price fluctuations and is self-balancing over the longer run. The manner in which this buffer, or 'price smoothing', has operated can be seen from the end-of-year balances which are published in the annual report of the Board. These show that a small credit reserve balance remained in 1938, followed by a loss of $5 million which was recovered gradually over subsequent years, the account returning to credit in 1944. Reserves were then built up fairly steadily to the peak credit of $54 million in 1956. Disastrous effects of dumping on the United Kingdom market caused the reserves to be drawn on, and by 1958 the account was in debit by $14.7 million which, however, was repaid the following year. The conditions of world dairy trade have been reflected by debit balances in the periods 1961 to 1964 and again in 1966 to 1970. A measure of recovery is indicated in 1970, since the estimated deficit for the year ended 31 May 1970 was only one percent of sales, at a time when market pressures have been great.

The reserve account showed credit balances in 18 and debit balances in 15 years. On average over the period the account has been in credit by $10 million.

For certain products, notably milk powders and casein, price smoothing is limited to the pooling of each season's realizations, without longer term provision, and no balances therefore remain.

Cumulative turnover on export sales in the whole period was around $N.Z.4,000 million. Annual sales now run at about $N.Z.230 million.

The Board holds out the offer to purchase a range of standard export products, subject to pre-conditions as to quality, delivery and so on, at prices based on export realizations but somewhat smoothed in the manner already described. Especially over the past 15 years, a very positive attitude to buying operations has evolved, and nowadays variations from standard products are common and increasing. They are brought about by way of 'non-standard' purchase orders which carry some incentive. Similarly developmental work is widely fostered as part of the Board's purchasing programmes, and by this means promising research work can be rapidly developed commercially. Variations to the pattern of manufacture as a whole are brought about first by influencing the companies with a flow of information and by consultation, creating a kind of 'price anticipation' atmosphere for their individual decisions. But where the sum of company decisions does not meet the Board's assessment of need, or where it may be desired for various tactical reasons to work counter to the stream, it is open to the Board to negotiate diversions of milk between products, factories or companies, using suitable incentives which are met from earnings.

The flow of purchasing in turn is closely integrated with the physical operations through stores throughout the country and through an ever-widening range of shipping services, which now reach ports of destination, numbered in scores, throughout the world.

A substantial change has been brought about in the range of products and of markets, as well as in the mobility in the use of milk, in research and development, and in the provision of resources. Increasingly diverse markets and greater versatility in marketing techniques have been matched by organizational developments in the base industry. An indication of the changing pattern of the business is given in the following figures of export realizations at f.o.b. ocean vessel:

($NZ million)

	Products		**Markets**		**Total**
	Butter & Cheese	**"Other" Products**	**United Kingdom**	**"Other" Markets**	
1936/37	42	—	41	1	42
1946/47	75	3	73	5	78
1956/57	111	12	106	17	123
1966/67	172	50	137	85	222

After a setback in 1967/68 and 1968/69, the results for 1969/70 (as yet not published) will show a recovery in total earnings and continuing development of non-traditional business.

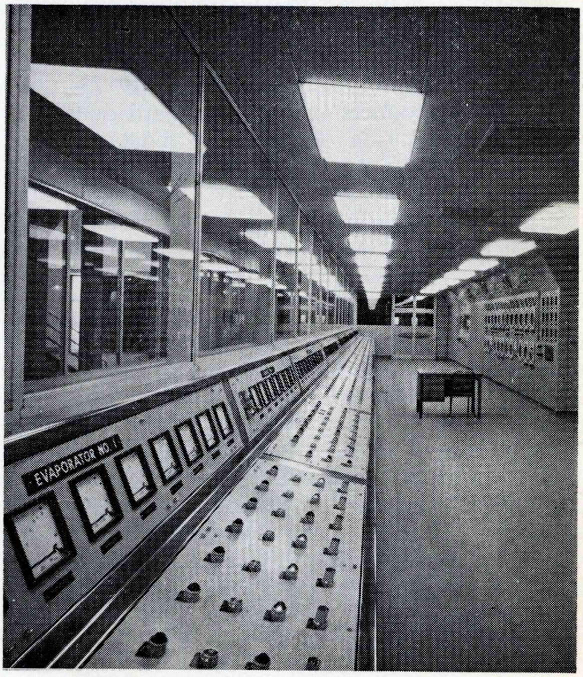
It will be noted that the share of earnings derived from the traditional market in the United Kingdom has declined from close to 100% to less than two-thirds in recent years, while substantial growth has occurred both in 'other markets' and 'other products'.

In terms of volume, the Board is now handling export products at the rate of over 550,000 tons a year.

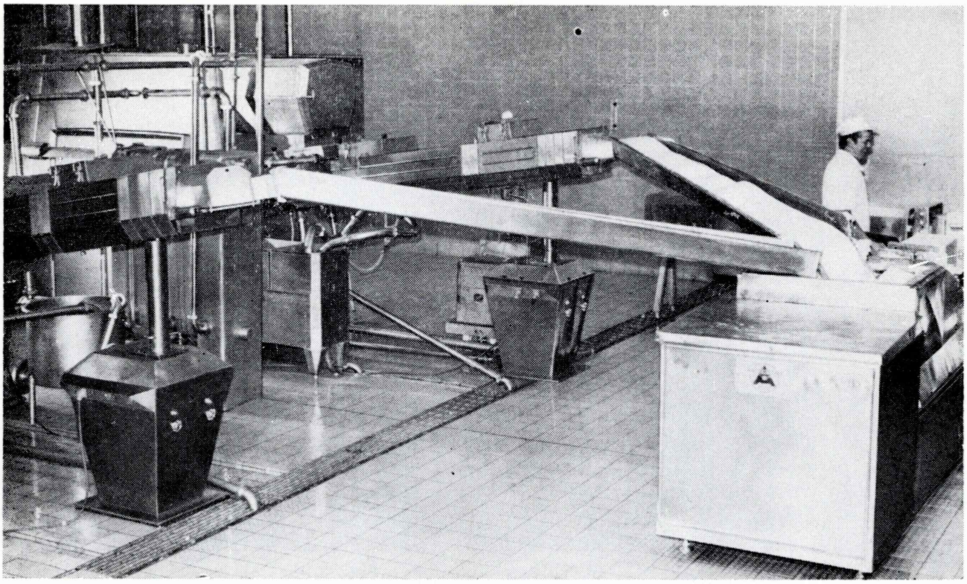
The External Environment

Having secured a grip on its production, manufacturing, and marketing affairs the industry is now reaching out more positively and confidently than before for ways in which its external trading environment can be improved. Inevitably the Board works closely with the New Zealand Government. It has always, of course, been clear that the trade depended upon external trading policies of other countries, and it is certainly not a new thing for the New Zealand dairy industry to face politico-commercial uncertainties. It is relevant that in the central marketing approach, from the start, the attempt has been made to spread these risks by widening the field of sales; and it has already been shown that real progress has been made, adding further commercial strength by broadening the range of products and mobilizing the manufacturing resources. But the past 20 years have seen a series of disappointments as first the United States, then Europe, and now Japan, have elected to support the production of high-cost milk, have allowed demand to be stifled, and have restricted imports. And it has been clear for many years that the United Kingdom could not (quite apart from questions of entry to the European Economic Community) provide an outlet for the rate of growth which the New Zealand dairy industry could and should readily show. The United Kingdom quotas for butter, and similar arrangements for cheese, have given some defence against the effects of subsidized dumping, but in their place is now the uncertainty of the terms upon which the trade would be done should the United Kingdom join the European Economic Community.

The debate about international trading conditions continues in a variety of places. In the GATT forum in Geneva, the New Zealand Government has been able to get to the table representatives of most countries concerned, and has made limited progress with an agreement for minimum export prices (which for them is to say maximum export subsidies) for skim milk powder, with hopes for further products. Discussions take place in London and Brussels about future trading arrangements with Europe as a whole. The New Zealand dairy industry's position as an economic trader operating without export subsidies is repeatedly stressed in Washington and elsewhere. Always the message is that if there is to be any sense or order in international trade there must be a place for what is commonly



Control room of a large milk powder installation. (*National Publicity Studios, Wellington*).



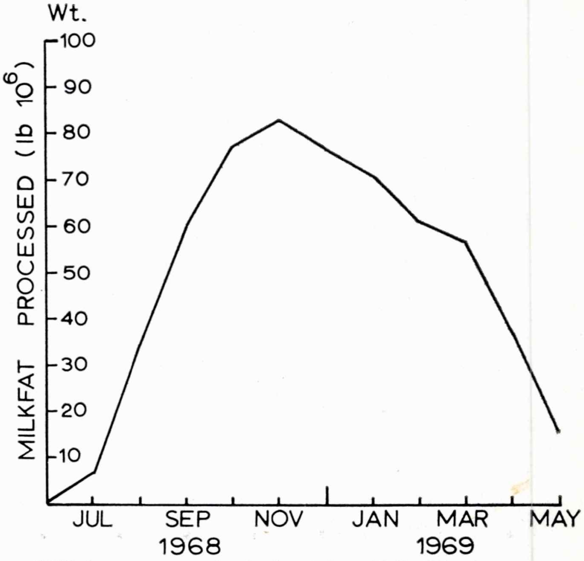
Contimab continuous buttermaking machine feeding into Anderson packer in Manawatu Co-op. Dairy Company's butter factory.

recognized as the most productive dairy industry in the world, and that distortions to trade by protected high-cost production and export subsidies should be eliminated in favour of allowing market influences and principles of comparative advantage to come back into effect.

By inference, if trade relations are so bad that an industry as clearly productive and efficient as the New Zealand dairy industry is to be denied fair market opportunities, there is as great potential danger for trade in industrial as for agriculturally based goods.

At the same time the attempt is being made to develop new trades among the so-called 'developing' countries, many of which are handicapped in their progress by difficulties similar to our own, arising as they do from barriers to trade in agricultural goods. The time scale is long, since in many cases the development of dairy trade must await basic economic and social development, but experience gained in the course of developing commercial trade, especially in milk recombining, technical innovation, and joint ventures in new markets, gives New Zealand valuable advantages. Activity in this field includes participation in the development of FAO and World Food Programme projects, nutritional education, and co-operation with customer countries in securing investment resources and outlets for their exports.

The New Zealand dairy industry is firmly based on highly productive farming and manufacturing, flexible and vigorous in its commercial operations, and so unified in its policy formation that it is capable, as no other dairy industry is, of coping with the hazards of its external trading environment without the need for subsidies and protection. The big questions before it are now almost entirely those of international commercial politics, and these are being approached with cool confidence because the arguments are so clear.



Milkfat processed during the 1968-69 season — a typical curve clearly illustrating the seasonal nature of milk production in New Zealand. (See following article).

New Zealand grazing system in practice.

DAIRY FARMING IN NEW ZEALAND

By J. W. STICHBURY

New Zealand Dairy Board, Wellington, New Zealand

Dairy farming in New Zealand is a highly specialized industry. There are some 24,000 dairy farmers who, on farms averaging about 130 acres in area, milk a total of 2,400,000 dairy cows. The average herd size of 100 is probably the highest in the world while the average stocking rate of 77 cows plus replacements per 100 acres is achieved under a pasture grazing system, supplemented when necessary with hay and silage made from conserved pasture. With the exception of the small proportion (10%) of dairy farms on which milk is produced on an all-year-round basis for liquid consumption, grain feeding is seldom practised, while housing of cattle is virtually unknown.

The very great majority of dairy farmers produce milk which is used to manufacture dairy products such as butter, cheese, skim-milk powder, and casein. Milk is collected from the farm daily by tanker, although in some of the more remote areas on-farm separation of milk is still practised and cream supplied to the dairy factory. In order to fit the feed requirements of their dairy herd as closely as possible to pasture growth, dairy farmers producing milk for manufacturing mate all their cows to calve in the early spring and do not produce any milk at all for a period of about two months in the winter. The typical farm is owner-operated with the owner carrying out most farming operations, sometimes with the part-time help of his family. But with the rapid increase in average herd size which has taken place in recent years the proportion of dairy farmers who employ non-family labour is increasing. Over 3% of dairy herds now contain 200 cows or more while there is a growing number of herds of over 300 and up to 700 cows.

The predominant breed is the Jersey, but in recent years there has been a rapid increase in the popularity of the Friesian which prior to this was confined mainly to herds producing milk for liquid consumption. The only other dairy breeds used to any extent are the Ayrshire and the Milking Shorthorn but neither of these breeds is widely used and their popularity appears to be declining still further.

Milk used for manufacturing is paid for according to the amount of milkfat supplied, with the price to the farmer being determined by the price received for dairy products on export markets. This is in contrast to the position in other dairying countries and results in very great emphasis on efficiency of production and, in particular, output per labour unit. As a consequence of this there has been a very considerable interest in milking equipment and systems of milking designed to maximize the number of cows milked per labour unit.

Geographically, dairy farming is carried out mainly in the North Island where climatic conditions are favourable for pasture production and all-year-round grazing. The Auckland province in particular can be described as the dairying province of New Zealand, some 66% of all dairy cows being located within it.

Development

The development of dairy farming in New Zealand can be conveniently divided into the period up to 1950 and the 20-year period since 1950.

In the first half of the century there was rapid development of dairying in response to the opportunity to export dairy products resulting from the introduction of refrigeration. From very small beginnings the industry had expanded by 1930 to the stage where some 1,500,000 cows were milked and the number of suppliers of milk or cream to dairy companies reached a peak level of over 70,000 in the 1933/34 dairying season. However, many of these suppliers were not engaged in specialized dairy farming but were people who milked a few cows to supplement incomes obtained from other sources and probably half of them had herds of fewer than 10 cows.

Exports of dairy produce over this period were limited almost entirely to butter and cheese, with butter being by far the major product. On-farm separation of milk was therefore widely adopted with the skim milk being retained on the farm and used as a basic food for pig meat production. The emphasis on butter production and payment for milk or cream on a milkfat-supplied basis resulted in a rapid increase in the popularity of the Jersey which soon replaced the Shorthorn as the predominant breed so that by 1950 Jerseys comprised 86% of all dairy cows. Average herd size, based on herds of ten or more cows, showed a steady increase and by 1950 had reached 50 cows.

During the first half of this century therefore dairy farming developed on a basis of mainly owner-operated farms, which generally supplied cream to dairy companies for the production of butter, produced pig meat as an integral part of the dairying operation, and had herds of predominantly Jersey cows.

In the 20-year period since 1950 there have been marked changes in this pattern. The development of markets for non-fat products, such as skim milk powder and casein, resulted in dairy companies changing to the collection of whole milk from farms by tanker. This had major effects on the pig industry in particular, since pig production was almost invariably discontinued on dairy farms when whole milk collection commenced. Whole milk collection was also accompanied by a very rapid intensification of dairy farming. The number of suppliers to dairy companies, still over 50,000 in 1950, declined by 1969 to under 25,000 while the average size of herds of 10 or more cows doubled from 50 to 100 cows. Most of the reduction in number of suppliers occurred in the period 1950 to 1960 and would represent mainly the elimination of "side line" suppliers. On the other hand most of the increase in average herd size has occurred in the last ten years and is due in the main to intensification on existing farms. During this period there has also been a marked increase in the popularity of the Friesian breed which is best illustrated by the demand for this breed in the Dairy Board's artificial breeding service. Whereas in 1956 just over 5% of the demand for semen from farmers producing milk for manufacturing was for the Friesian breed, this had increased by 1969 to 42% of the total demand.

Management of Dairy Farms

The management of virtually all dairy farms in New Zealand is organized around a system of pasture grazing and, except for farms on which milk is produced for liquid consumption, on a calving pattern under which the whole herd is mated to calve during a short period in the early spring. The aim therefore has been to develop systems of husbandry and management which maximize pasture production and pasture utilization under grazing and adjust the amount of feed made available to the cow according to her requirements. The key features of such systems are:

- The use of artificial fertilizers, in particular phosphatic and potassic fertilizers, to correct soil nutrient deficiencies;
- High stocking rates to obtain good utilization of the pasture produced;
- Controlled grazing to enable a system of spelling between grazings to be followed and to permit variation of intake according to varying requirements throughout the year;
- The conservation of surplus pasture growth either as hay and silage or saved pasture, for feeding during periods of limited pasture growth, such as during the winter, or when feed requirements are high, such as during the early part of the lactation.

Under high stocking rates, which in New Zealand range up to 150 cows per 100 acres, considerable skill is required to manage a dairy farm so that adequate feed is made available to meet the varying requirements of the herd. Decisions

Recommendation

which can have an important effect on the production obtained include: selection of the optimum stocking rate, determination of calving dates, the timing of measures used to restrict intake and the extent of the restriction imposed, and the system of management adopted during periods of reduced pasture growth such as in dry summers and during the winter. The farmer is in fact dealing with an animal-pasture interaction which means that only rarely can decisions be made on the basis of the effect on either the animal, or the pasture, alone. Almost invariably the decision must take into account not only the immediate effect, but also the long-term effect on the other component. An example of this would be the grazing of saved pasture during a period of wet weather in the winter. While the feed thus made available may be highly beneficial to the animals at the time, the resulting damage due to treading will almost certainly result in considerably reduced pasture production in the following spring. The correct decision, therefore, may be to forego the immediate benefit in favour of the long-term benefit of higher pasture production in the spring by delaying grazing until drier conditions are experienced.

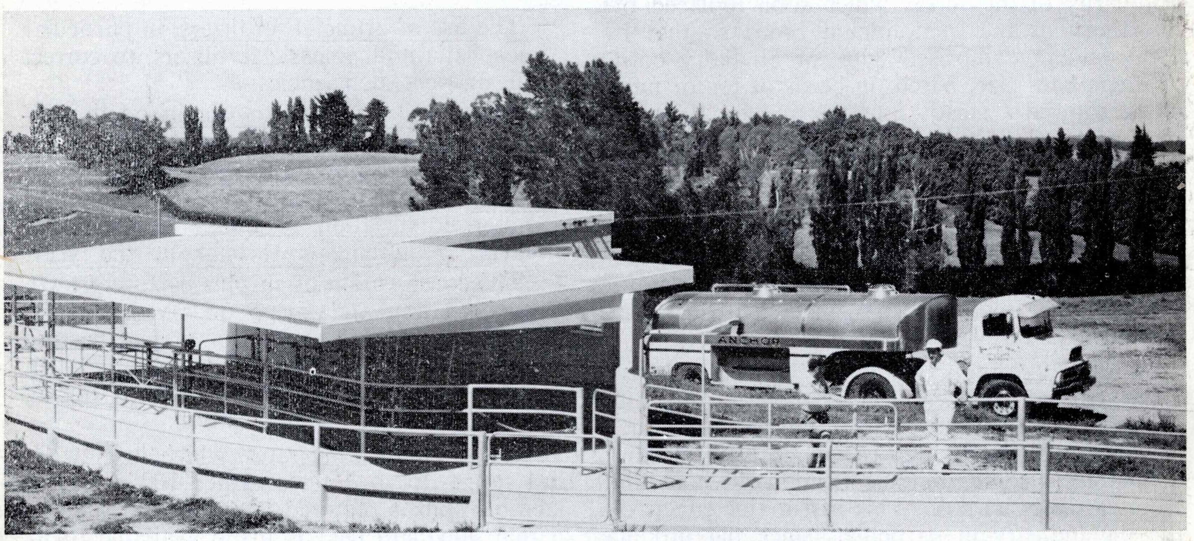
Intensive systems of grassland farming are also complicated by the fact that weather conditions can vary markedly from the norm for the period concerned. Under high stocking rates the whole system can be very vulnerable, because of this, unless appropriate steps can be taken. In New Zealand such steps include:

- The use of nitrogenous fertilizers to increase late-winter and early-spring grass growth;
- The feeding of meal during the early part of the lactation if pasture is in short supply;
- In areas with poor-draining soils the use of wintering pads and barns where dry cows can be fed on hay or silage thus avoiding pasture damage during periods of wet weather.

Routine use of meal feeding and nitrogenous fertilizers has not, however, been demonstrated to be profitable at the level of prices received by New Zealand dairy farmers. But such use may be profitable at still higher rates of stocking and work is currently being carried out to examine this. It has also been suggested that modification of the management system towards greater reliance on stored feed and yard feeding systems will be required to obtain still higher intensification.

Milking

Because of the importance of milking in determining labour requirements on New Zealand dairy farms, milking systems have received very great attention. Machine milking was adopted at a very early stage of the development of dairy farming and by 1950 had been followed by the almost universal adoption of non-stripping. The milking sheds of that time were, however, almost invariably of the "walk-through" type, in which each cow has to enter and leave singly. While "doubling up" resulted in increased throughput in many of these sheds it was evident that a major change in approach would be required if throughput per labour unit was to be still further increased. Attention was therefore turned to the principle of elevated batch milking and the herringbone milking shed, which combined



A typical early morning scene — herringbone cow shed and milk tanker. (*National Publicity Studios, Wellington*).

these principles in a relatively simple layout, replaced the walk-through shed on a number of dairy farms in the early 1950s. When surveys showed that in general this resulted in increased throughput per labour unit there was a rapid increase in the adoption of this type of shed and the development of refinements to expedite the entry and exit of cows. By 1968 herringbone milking sheds were being used on 36% of dairy farms while there was almost universal adoption of this type of shed by owners of large herds. It is in fact almost certain that the development of large herds in recent years has been a direct result of the adoption of this type of shed. To accommodate these large herds some very large units have been installed ranging up to 50 cows a side.

The most recent development is the circular milking shed with a revolving platform. Although it is too early yet to obtain a clear indication of the performance of this shed in comparison with the herringbone there is certainly very widespread interest in it.

Herd Improvement

Herd recording is carried out by six Herd Improvement Associations licensed by the New Zealand Dairy Board which, under its Act, is responsible for the overall direction and co-ordination of herd recording. Four systems of recording are offered: monthly, where the interval between recording visits is approximately 30 days; alternate-month, where the recording visits are made at intervals of approximately 60 days; production ranking, where milk weights and samples are taken twice during the lactation; and owner sampling.

In the 1969/70 season some 30% of dairy herds were recorded.

Milk yield is determined at each recorded milking by the use of milk meters and milkfat testing is usually carried out by the recording officer, using the Gerber system. Data obtained by the recording officer are processed by the Dairy Board on its computer and on behalf of the Associations the Board prepares the returns sent to the recording farmer. Production and identification data thus obtained by the Board are used in research and for progeny testing purposes. As well as the estimated yield of each cow, participating farmers are provided with an index for each cow, which is calculated after correcting for age and time of calving, and is designed to enable increased accuracy of selection.

Progeny testing of dairy bulls has been carried out by the Board since 1936, and since 1949 the system used has been based on a comparison of the production of the bull's daughters with that of their herd mates. In order to make such comparisons it has been necessary to use age-corrected records, but within-age comparisons are now used as well when sufficient contemporaries are available.

Following the introduction of progeny testing, work was commenced by the Department of Agriculture, in conjunction with the Board, to develop a system of artificial insemination suited to New Zealand conditions. This resulted in the introduction of commercial artificial breeding by the Board in 1950. Semen is sold to Herd Improvement Associations which, in turn, provide the field service. This has now become the major system used to obtain genetic improvement of dairy herds, some 60% of dairy farmers using this service in 1969. Selection of the bulls to be used is on a similar basis to that used in many other countries. Young bulls are selected on the basis of ancestry and are mated to sufficient cows to enable them to be proven. They are then laid off until their progeny tests are available, when the best of them are selected for use as proven bulls. About 10% of the bulls originally selected on ancestry are retained for use as proven bulls, with about 5% being extensively used.

One of the problems in the operation of an artificial breeding service in New Zealand is the very short mating period required in the great majority of herds. This results in a very heavy demand for the service in the late spring/early summer period, and to meet this demand without a very large number of bulls requires very intensive use of bulls over a short period. Accordingly, research has concentrated on obtaining the maximum number of inseminations per ejaculate and in excess of 50,000 inseminations per bull can now be made from the semen collected in 12 to 14 weeks. The short mating period also precludes the employment of very many full-time inseminators by Herd Improvement Associations. Consequently the majority of inseminators are employed on a part-time basis and are in the main recruited from the farming industry itself. Semen from three dairy breeds and one beef breed is made available, but 95% of the demand is for two dairy breeds, the Friesian and the Jersey, with the demand for Friesian semen increasing each year at the expense of the Jersey. Because of the large average herd size and relatively low cost of keeping bulls in New Zealand there has been very little demand for artificial breeding as a means of bull replacement. Consequently the service was designed from the outset, and has remained, as a purely herd improvement measure.

Beef from the Dairy Herd

Because of the specialized nature of dairying in New Zealand and the dominance of the Jersey breed, New Zealand lagged behind some other countries in utilizing surplus calves from the dairy industry for beef production. In recent years, however, there has been a rapid increase in the number of calves reared for this purpose and at least part of the increase in the popularity of the Friesian breed is due to this factor. Until last year most of these calves were sold at weaning to sheep farmers who reared them on to slaughter age. But in 1969, as a means of slowing down the rate of increase in dairy production in view of overseas marketing problems, the Government introduced a diversion payment for dairy calves reared for beef on dairy farms. This resulted in a considerable increase in the number of calves retained on dairy farms and reared as beef.

Research and Advisory Services available to Dairy Farmers

The Department of Scientific and Industrial Research has a number of divisions carrying out research of importance to dairying such as soils, plant breeding, pasture ecology, plant biochemistry, and plant physiology. Particularly well known in relation to dairying is the work carried out by the Grasslands and Applied Biochemistry Divisions at Palmerston North in relation to the breeding of grasses and clovers, the development of pasture management systems, and the control of bloat.

The Department of Agriculture has two major research stations carrying out research into dairying problems. At the Ruakura Agricultural Research Centre research is carried out into fertilizer requirements of different soils, dairy husbandry, and dairy cattle breeding, while at the Wallaceville Animal Research Station research is carried out into problems of animal diseases. The Department of Agriculture also operates an extensive system of field research, both on commercial farms and at various demonstration farms. A feature of the Ruakura Agricultural Research Centre is its Annual Farmers' Week at which papers are given by Ruakura workers and others and a very comprehensive field day is held to demonstrate recent research findings.

In addition to these two major Government Departments, research of importance to dairying is also carried out at both Massey University and Lincoln Agricultural College, both of which also hold annual farmers' conferences, and by the Farm Production Division of the New Zealand Dairy Board which carries out most of the surveys into dairy farm practices and the major research effort into herd recording systems, dairy cattle breeding, and artificial insemination.

In addition to veterinary advice, which is available from several sources, dairy farmers have the choice of a number of advisory services when they wish to obtain advice on the management of their farms.

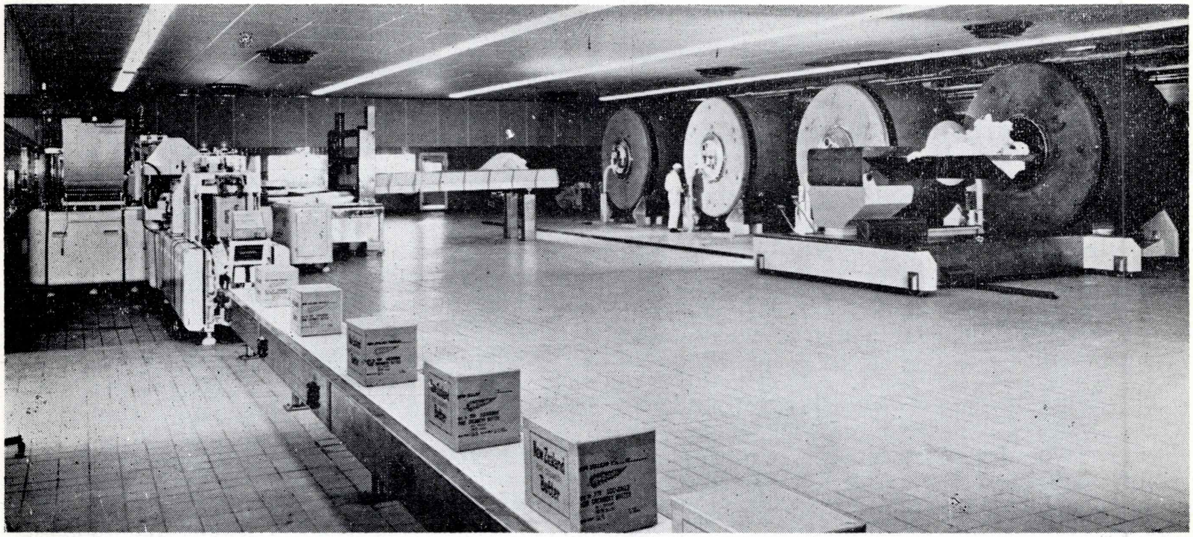
The major farm advisory service is operated by the Department of Agriculture, which has advisers located in all farming districts and provides a comprehensive service covering virtually all aspects of farming from soil and water management to farm business management. In addition, officers of the Dairy Division of the Department are available to advise farmers on the siting and construction of milking sheds, systems of milking, and dairy hygiene.

The New Zealand Dairy Board plays an important role in dairy farm advisory work through its Consulting Officer service. These officers are located in all the major dairying districts and provide an advisory service covering all aspects of dairy farm management. An important feature of the advisory services provided by these officers is the formation of discussion groups, of usually up to ten farmers, which meet regularly to discuss management problems. An interesting recent development in this sphere is the formation of groups in which membership is restricted to the owners and managers of large herds, who are thus able to concentrate on the special problems met with in the management of such herds. Other organizations which provide advice to farmers without charge include a number of commercial firms, and Government Departments concerned with land development and soil conservation.

A more recent development in New Zealand has been the growth of advisory services which charge for the service they provide. The initial move in this direction came with the development of the Farm Improvement Club service. These Clubs employ one or more advisers and the participating farmers pay a fee for the services they obtain from their adviser. In these Clubs the adviser-to-farmer ratio is much higher than in other types of advisory services and consequently the advisers are able to provide very detailed advice on the management of Club members' farms. The development of Farm Improvement Clubs has been followed by the setting up of private farm management consulting services which provide advice to farmers on a range of farm and business management topics.

Dairy farming in New Zealand is a soundly based efficient industry, highly specialized and backed by extensive research and advisory facilities. Provided it continues to obtain the markets for its produce that its efficiency deserves, its future seems assured.

THE MANUFACTURE OF DAIRY PRODUCTS IN NEW ZEALAND



Buttermaking room at Morrinsville Co-op. Dairy Company's butter factory showing four Anderson Mark VII 130-box stainless steel churns, mechanized unloading equipment, and Vickers bulk packing line.

BUTTER

By R. M. DOLBY

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Small quantities of butter were exported from New Zealand as early as the 1850s, but it was not until the introduction of refrigerated ships in 1885-91 that annual exports exceeded 1,000 tons. Exports then increased rapidly and reached 10,000 tons in 1902/03 with change from farm to factory manufacture. Expansion between 1925-35 was again rapid and brought exports to 140,000 tons at the end of this period. Further regular expansion in production after the war period has more than met the needs of an increasing population.

At the present time several other dairying countries produce much more butter than does New Zealand (see Table 1), but in this country local consumption, although at the high rate of 43 lb per head per annum, uses less than 20% of production. The quantity thus available for export makes New Zealand the world's largest exporter of butter (see Table 2). These exports have always gone mainly to Great Britain, and even in 1969 this market was the destination of 90% of butter exports. Butter is by far the most valuable dairy product manufactured in New Zealand and in recent years it has accounted for almost 60% of the value of dairy exports.

Table 1. *Butter production by main producing countries, 1969.*

	Thousand tons
USSR	1,079.0*
West Germany	509.7
United States	506.8
France	468.0
New Zealand	267.0
East Germany	218.9*
Australia	199.2
Canada	157.6
Denmark	144.1
Poland	123.7
Netherlands	110.1
Finland	100.6

* 1968

Table 2. *Total exports from main butter-exporting countries, 1969.*

	Thousand tons
New Zealand	217
Denmark	99
USSR	74*
Australia	65
France	50
Netherlands	50
Irish Republic	39
Belgium	20

* 1968

In the early days of the industry much of the butter was made on the farms, and that made in factories was from cream separated in the factory. The bringing into production of further areas of land and the equipping of dairy farms with separators resulted in a swing to farm-separated cream for buttermaking. In 1930-45 about 95% of the cream for buttermaking was farm-separated.

A trend towards collection of whole milk to take advantage of the market for milk powders and casein was facilitated by the use of milk tankers. By 1960 55% of the milkfat supplied to dairy factories was received as milk. This has increased to 79% in 1966 and over 90% at the present time.

This change in recent years has greatly altered factory design. The large receiving stage with roller conveyors for transporting cream cans past grading, sampling, and weighing stations to a tipping point and thence to a can washer has disappeared. Instead, there is only a series of connections for tanker hoses, while milk volume records and samples are brought in by the tanker drivers.

Buttermaking Equipment

Factory equipment has also changed markedly over the years. Pasteurization of cream, preceded by neutralization of acid cream with sodium bicarbonate, has been practised since the early years of the century. The original flash pasteurizers were replaced during the 1930s by the Vacreator Vacuum Pasteurizer developed in New Zealand. This equipment, as well as pasteurizing the cream by direct contact with steam, gave a very effective deodorization by boiling the cream under reduced pressure. Because of its efficient removal of feed taints the Vacreator soon became indispensable in all New Zealand butter factories. Improved models of the Vacreator or other plant performing the same function are still standard equipment today.

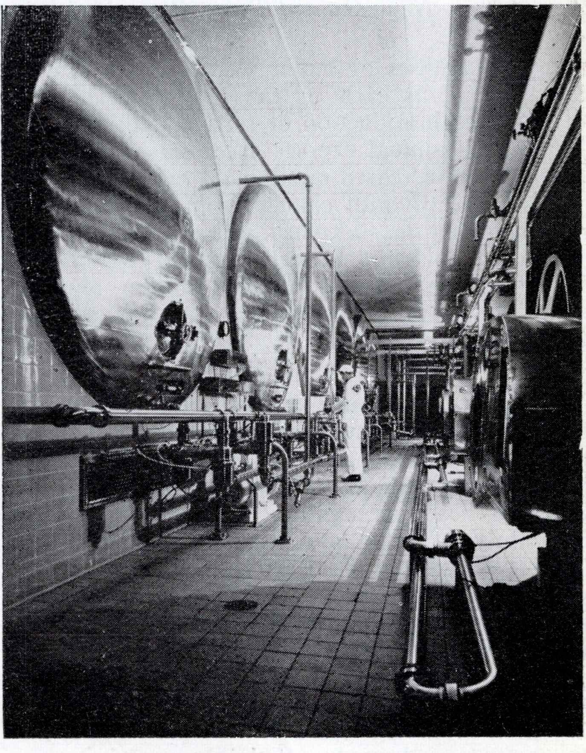
Cream coolers have progressed from open surface coolers with water and direct expansion cooling to plate heat exchangers with chill water cooling. Holding vats have evolved from those with an ammonia-cooled ice bank in the jacket, through vats with bonded coils to the present vertical or horizontal vats with chill water spray-cooling in the jacket.

Churns, all developed in New Zealand, have passed through the stages of wooden churns with internal workers, to rollerless churns and thence to stainless steel churns which now have a capacity up to 7,000 lb of butter. All these have been in the form of a horizontal cylinder with an end opening. Butter is unloaded on to a platform inserted through the churn door.

New Zealand factories changed at an early stage from the use of tinned steel or brass to all stainless steel equipment, thus reducing contamination of produce with copper and iron to a low level. Corresponding changes in farm milking machines and vats have still further improved the situation.

Butter is packed for export almost entirely in the form of 56 lb units. Blocks of butter are wrapped in vegetable parchment, or parch-foil if the butter is unsalted, and are placed in an outer container, originally a white pine box and later, after 1950, a solid fibreboard carton.

The standard equipment for many years for forming the 56 lb blocks of butter has been the Anderson packer. This machine has a large hopper which will accept a roll of up to a ton of butter from a trolley which is raised and tilted hydraulically. A pair of auger screws at the bottom of the hopper feeds the butter as required through a mouthpiece from which the butter is extruded in rectangular form of the



Cream storage vats at Morrinsville butter factory.

correct dimensions. A standard length is cut off by a pair of cutting wires. The block is passed on to a scale platform for weight adjustment and then to wrapping and cartoning stations.

These operations have been performed manually, though some partial mechanization has been attempted. In the last two years two New Zealand-designed machines have come into use which carry out automatically all packing operations, except weight adjustment. The number of workers on the packing line, 12 to 14 for a large factory, can now be reduced to two or three.

After packing, the butter is usually transferred to a coolroom and transported on the following day to the cold store at the nearest port. There it is graded immediately on arrival.

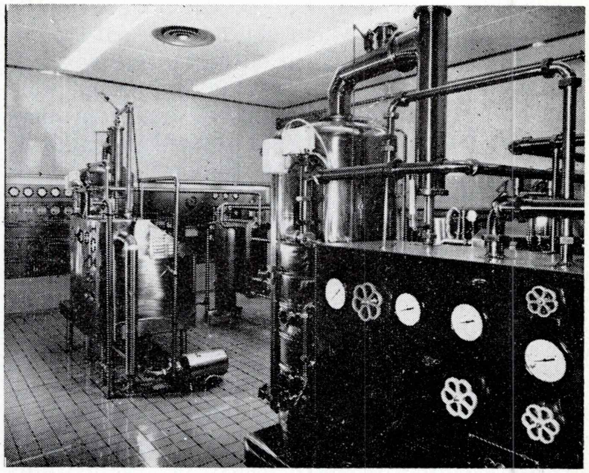
Principles of Buttermaking

Owing to the distance of the main export market, New Zealand buttermakers have always had to attach prime importance to good keeping quality of their produce. Standards have been maintained by examination by Department of Agriculture graders of one carton from each churning on arrival at the port store. Further examinations of a proportion of the produce on its arrival in England are made by the same Department.

As a sour-cream, highly flavoured butter of the Danish type does not keep long, even in cold storage at 10-15°F, New Zealand has concentrated on a sweet-cream, mild flavoured butter with a pH value of not less than 6.5. When farm-separated cream which had sometimes developed acidity was used for buttermaking, neutralization to the desired low acidity was necessary. With the present system of whole milk collection, the factory-separated cream rarely requires neutralization.

A good deal of research work has been done in New Zealand on the development of a fuller flavour in the sweet-cream butter without impairing its keeping quality. Much of this work is summarized in "The Buttermaker's Manual" (McDowall, 1953a) which also gives a detailed account of all butter factory practice to that date (see also McDowall, 1962).

The efficiency of methods of deodorizing cream to remove feed and weed taints and to achieve the most efficient use of steam has also been investigated in detail (McDowall, 1953b, 1956, 1957; Scott, 1957) and has formed a basis for the latest designs of vacuum pasteurizing equipment.



APV cream-treatment plant and automated control panel at Morrinsville butter factory.

Investigation of the effect of manufacturing methods on body and spreadability of butter (Dolby 1954, 1959) showed that conditions of cream-cooling after pasteurization have a pronounced effect. Some of these findings have been made use of in current butter factory practice and give a more plastic butter than would otherwise result. More recent work (Taylor and Dolby 1970) has shown that reworking of butter after storage, as occurs with all New Zealand butter before it reaches the market in England, gives a permanent reduction in hardness and reduces the difference in hardness between butters made in different ways. More elaborate cooling techniques in the butter factory are therefore not justified.

No major changes in buttermaking practice have been made in the last ten years. The introduction of continuous buttermaking machines and further developments in modified milkfat will, however, bring about much greater changes in the next few years.

Continuous Buttermaking

New Zealand has kept buttermaking developments in overseas countries under close observation. One method of continuous buttermaking judged worthy of trial was the Alfa process operated on a commercial scale in New Zealand in 1947/48. This process depended on reseparation of cream to give a plastic cream of the same fat and moisture contents as butter. On cooling in a "transmutator" this cream was converted to butter. The process was rejected because of body defects in the butter and the fact that it was frequently impossible to keep the moisture content below the legal maximum of 16%.

The development in Europe of the Fritz buttermaking machine, which churned normal cream very rapidly with a high-speed beater and worked the butter granules in a continuous process, was watched with interest. Salting of butter in this machine, however, presented difficulties, and it was not until one company, Simon Frères, had developed a suitable system that a trial was made in New Zealand. A Contimab MB5 was operated by the New Zealand Dairy Research Institute in a commercial factory in 1964/65. This trial showed that the process could make butter fully acceptable to New Zealand's markets. Saving in labour, as compared with the efficient system already in use in New Zealand, would however, be small but there were appreciable savings in capital cost and building space. The company involved in the original trials, the Manawatu Co-op. Dairy Co., shortly afterwards purchased two larger machines of the same make to equip a new butter factory (described later). Soon afterwards the New Zealand Co-op. Dairy Co. installed Westfalia machines and the Rangitaiki Plains Dairy Co. a Silkeborg machine. Several other dairy companies have since purchased buttermaking machines of one or another of these three makes. All the manufacturers have acceded to demands for larger machines to suit New Zealand conditions and those installed range from 3 to 5 tons per hour capacity as compared with 1 ton per hour for the original machine. The later machines have all incorporated numerous improvements in design.

It is expected that some 60,000 tons of butter will be made in continuous machines in the present season and about 100,000 tons in 1971/72.

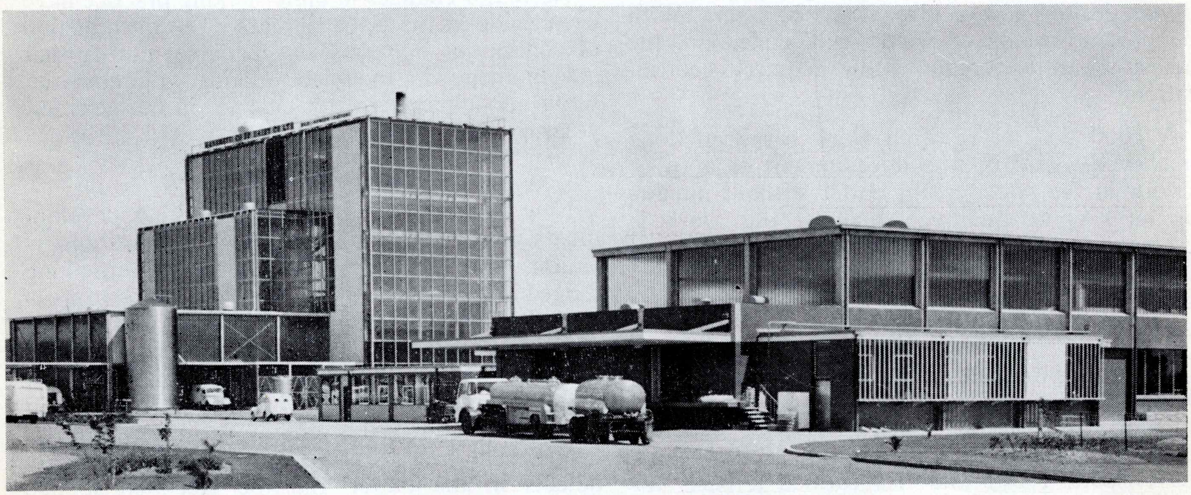
Economic studies by Jebson (1969, unpublished results) have shown that continuous buttermaking machines offer no savings in operating costs for factories making less than 5,000 tons of butter per year but that they can show increasing economies as the output rises above this level.

Factories entering on continuous buttermaking have frequently had difficulties with spotted or uneven colour or in obtaining consistent moisture control. These difficulties, however, have been overcome by the use of suitably fine salt (50 micron), with improved techniques of handling salt slurry, by avoiding the mixing of different lots of butter in the packer, and by careful control of cream fat test and temperature. Some of the continuous butter has gained higher grades than the best conventional butter.

Buttermaking using Conventional Churns

The Morrinsville Co-op. Dairy Company's butter factory is a good example of buttermaking on a large scale using conventional churns (Anon., 1966). This factory opened in 1966 with an initial capacity of 10,000 tons of butter per annum, but with some additional equipment could produce 20,000 tons.

Processing equipment is all on one floor while a basement houses refrigeration equipment and tanks for raw, chlorinated, and chilled water, and carries all the services. Production areas are floored with vitric tiles. A plastic finish is used on upper wall surfaces and ceiling. The whole processing area is supplied with conditioned air filtered to "whiteroom" standards.



Part of Manawatu Co-op. Dairy Company's new factory complex showing powder factory in background and butter factory in foreground. (*C. Rofe, N.Z. Dairy Research Institute*).

Cream from an adjacent milk powder plant is pasteurized in APV Paradisk Cream Treatment units and held after cooling in 6,000 gal insulated storage vats with chill water sprayed against the inner liner to provide cooling. Temperatures are thermostatically controlled. Vats and other equipment are fitted for automatic cleaning-in-place operated from a control panel which also indicates contents of vats.

The buttermaking room of 13,000 sq. ft contains four churns with space for an additional churn. These are of "130 box" size, i.e. 7,000 lb of butter. They are unloaded on to a mechanically driven platform which transports the butter to a tilting table which transfers it to the packer hopper. The packer, designed to be completely automatic, extrudes the blocks of butter, wraps them in parchment, and inserts them in cartons which are glued and taped. A conveyor takes the cartons directly to railway wagons which have been precooled by chilled air supplied through flexible ducting.

Buttermaking using continuous churns

The Morrinsville Co-op. Dairy Company and the Manawatu Co-op. Dairy Company's new butter factory at Longburn provide a good comparison between conventional and continuous buttermaking on approximately the same scale. Opened two years after Morrinsville's factory, the Manawatu butter factory was designed entirely for continuous buttermaking with a capacity of 13,000 tons per year and capable of extension to 20,000 tons. Construction of the factory is fully up to modern standards with tiled floors and walls and a fully filtered air supply.

Whole milk delivered by tanker is separated in the adjacent powder factory (shown in the photograph) and the cream is pumped to the butter factory. It is pasteurized either in an APV Paradisk or a Vac. 16 Vacreator which together have a capacity of 3,600 gph. After cooling in a plate heat exchanger, the cream is stored in 10,000 gal vertical holding vats with automatic temperature control. For continuous buttermaking the cream is standardized to 39-40% fat content.

The buttermaking equipment originally consisted of two Contimab MB20 and one MB5 machines. A Contimab MB50 with a capacity of 5 tons of butter per hour has since been added.

For local trade, butter is delivered to a Simon Fréres patting machine with a capacity of 90 1 lb pats per minute, with an associated carton-filling machine. For export the butter goes to an extruder which delivers 56 lb blocks. After manual weight adjustment, these are fed to an Anderson Cartonmatic which wraps the blocks and places them in cartons which are glued and taped automatically at the rate of 240 cartons per hour. The packed butter is loaded onto pallets and transferred to a coolroom where it is held prior to despatch to the port store.

Other Products from Milkfat

In addition to conventional and continuously made butter, New Zealand also exports canned butter for tropical use, ghee, and anhydrous milkfat. The latter is used for making recombined milk products or recombined butter. Sales of anhydrous milkfat totalled 11,000 tons in 1969/70, equivalent to 13,500 tons of butter.

A possibility of an increased diversification of products from milkfat is offered by a process for separating the fat into constituents of high and low melting point by fractional crystallization. Investigation of this process on a pilot-plant scale by the New Zealand Dairy Research Institute has shown that the fractions can be reconverted to butter which has either greatly improved spreadability at low temperature or better stability under tropical conditions. The fractions also have possibilities for use in baked goods and other food products in which their higher or lower melting point is an advantage.

The future should thus bring a greatly increased variety of products from milkfat to appeal to a wide range of markets.

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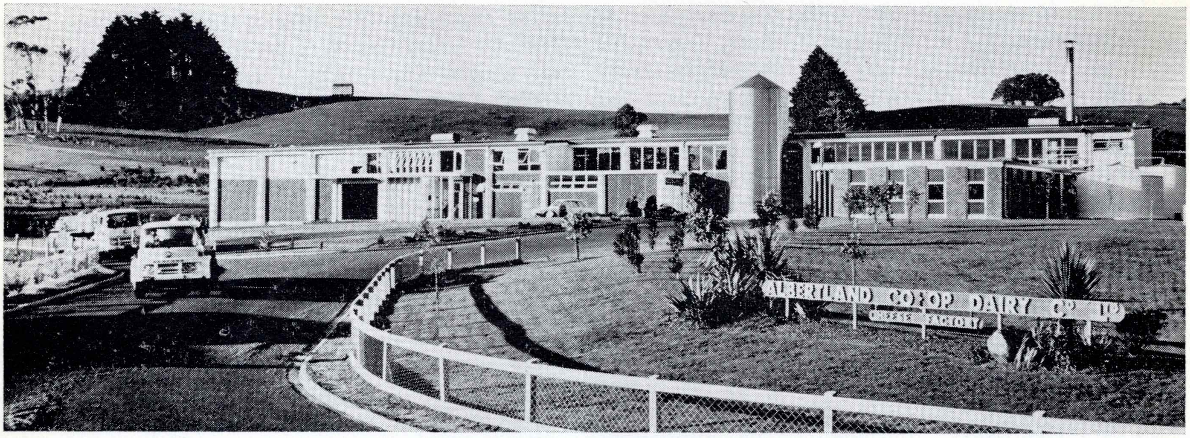

The new Warkworth cheese factory of the Albertland Co-op. Dairy Company. (*C. Rofe, N.Z. Dairy Research Institute.*)

CHEESE

By P. S. ROBERTSON

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New Zealand was settled by people, mainly farmers, from Great Britain over 100 years ago. Amongst the traditional skills of the settlers was a knowledge of farmhouse cheesemaking and the hard, long-keeping varieties were produced for the local and the United Kingdom markets well before the turn of the century. The outstanding ability of Cheddar cheese to withstand the six-month sea voyage to the market led to this variety becoming the main type produced in New Zealand. Only in the last 20 years has there been any significant production of other varieties of cheese but even today Cheddar represents some 80% of the 100,000 tons of cheese produced each year. Other varieties of export or local market importance are: Blue Vein; Cheshire; Colby; Cottage; Cream; Danbo; Fetta; Gouda; Granular; Gruyere; Havarti; Monterey; and Nuzano, a hard, grating cheese of the Grana type.

Because Cheddar cheese represents such a large proportion of total output the manufacture of this variety forms the main subject of this article.

Milk Composition and Quality

As the milk used for dairy product manufacture is still paid for on the basis of its fat content, Jersey cows predominate in the herds from which the milk is drawn. This breed and the high plane of nutrition which applies on most dairy farms means that the fat content of the milk is appreciably higher (national average 4.7% fat) than that of milk used for cheesemaking in other countries. Apart from a few specially licensed factories making cheese for particular markets all Cheddar cheese is made from natural, full-cream milk.

On the farm the evening and following morning's milks are usually held in bulk tanks, of which about 50% are mechanically cooled, pending collection. About 90% of all milk destined for cheesemaking is transferred to the factory by tanker. At the factory the milk, like all milk used for dairy product manufacture, is subject to a series of daily tests for quality. The examination applied to cheesemilk includes a daily organoleptic test and a visual examination of a renneted curd which includes a methylene blue reductase test and, at least once in each 10-day period, a test for antibiotic or other inhibitory substances by a modification of the bromo-cresol purple method of Berridge (McGillivray, Robertson and Liddell, 1966); the finished cheese is usually used for checks for the absence of DDT or its analogues. The foregoing mandatory tests are subject to checking by the New Zealand Department of Agriculture. In addition, the laboratories associated with factories make supplementary checks on milk quality, such as determination of the presence of added water and plate counts of undesirable micro-organisms.

Milk Pasteurization and Cheese Starters

All milk used for cheesemaking in New Zealand must be pasteurized with a minimum heat treatment of 15 sec holding at 70°C.

During the 1930s Whitehead established that the use of pure cultures of homofermentative starter bacteria (single strain starters) in place of the unknown mixtures in use as starter at that time (commercial mixed starters) improved cheese texture, gave better reliability, and reduced cheesemaking times. Single strain starters quickly became popular for Cheddar cheesemaking and have been used throughout New Zealand and quite widely in other countries for at least two decades. In this country the strains are characterized, maintained, and distributed by the New Zealand Dairy Research Institute. Through the use of pure strains Whitehead and his colleagues were able to establish that bacteriophage were responsible for the well-known erratic behaviour of starters and evolved a series of measures for the protection of mother cultures and bulk starters. The most important of these are the use of different strains (without phage relationship) on different days in a rotation, rigorous methods of aseptic propagation, and water-sealed bulk starter vessels. These developments have been reviewed by Robertson (1966). In recent years almost all cheese factories have been equipped with bulk starter vessels of 100-300 gal capacity.

The vital role of starters in cheese flavour development under New Zealand conditions has been established by R.C. Lawrence and his colleagues (1968, 1969) who have shown that certain single strains of *Streptococcus cremoris* and *Streptococcus lactis* are responsible for flavour defects such as bitterness and fruitiness, while other strains consistently give cheese of good flavour.

Conventionally Equipped Cheddar Factories

Work in New Zealand on the mechanization of the cheesemaking process over the past decade has led to the introduction of labour- and cost-saving in many factories. The majority of factories, however, are still producing cheese by the semi-mechanized methods which have evolved gradually over the past 50 years.

Komakorau

The Komakorau Branch of the New Zealand Co-op. Dairy Company is typical of the conventionally equipped cheese factories in this country. With a daily intake of milk of 12,000 gal it is of medium capacity. Like most New Zealand cheese production units this factory is clean and bright, as is appropriate to a food processing unit. It is attractively set out and, being in a rural area, the site includes amenities such as housing and hostels for staff. In accordance with New Zealand Co-op. Dairy Company practice, the six tankers which collect and deliver the milk are based elsewhere at one of the Company's large tanker washing and parking stations.

After pasteurization at 8,000 gph the full-cream milk, at 31°C, is pumped to one of twelve 1,000 gal rectangular stainless steel vats. During filling of the vat, starter (about $1\frac{1}{2}\%$) is poured in from the 20 gal cans which are used to transfer equal quantities of each of two starters prepared in separate bulk starter machines. As soon as the vat is full, calf vell rennet is added and briefly stirred in by the paddles of a travelling agitator.

After a 30 min setting period the coagulum is cut by hand using knives with blades $\frac{3}{8}$ in. apart. Stirring of the curd commences shortly after cutting and a few minutes later steam is introduced into the jacket surrounding the vat at a rate which will raise the temperature of the curd and whey to 39-40°C in not less than 30 min. Some 2 h later, when acid development is appropriate, agitation is stopped and the whey is run off. A central "drain" is formed in the curd and a little later drainage is assisted by passing mechanical peg stirrers through the curd several times. The whey is pumped to a tank where it is held prior to separation and disposal to pig farmers or used for whey powder manufacture. The whey cream is sent to another factory where it is converted to whey butter.

When cheddaring acidity has been reached (0.19% lactic acid) the curd is piled against the vat wall and allowed to fuse or "cheddar". About 20 min later the curd is cut into blocks which are turned side-for-side and end-for-end at intervals to assist fusion and moisture expulsion until the desired milling acidity of 0.55-0.65% lactic acid is reached some $1\frac{3}{4}$-$2\frac{1}{4}$ h after running off the whey. The cheddared blocks are then lifted into a mill positioned above the vat and divided into fingers. After further mechanical stirring salt is broadcast over the curd and stirred-in during the next 30 min.

A weighed quantity of salted curd is transferred by bucket into stainless steel hoops lined with two cloths. The hoops are pressed at 65 psi for about 10 min. Pressure is then let off and the lids removed so that the cloths may be pulled up. The hoops are then returned to the presses and pressing continues overnight. Next morning the cheese are shaken from the hoops, the cloths removed, the 'lip' on the cheese pared off and the weight of each block adjusted to 40 lb 2 oz by further paring. The blocks are then wrapped in a wax-coated film and over-wrap before sealing in a "hot-box". Each cheese is next placed in a carton and sealed in a mechanical gluing unit before transfer to the curing room (13°C) where they are held in cooling racks for about 24 h prior to open storage. Fourteen days after manufacture the cheese are transferred to Auckland for grading by officials of the New Zealand Department of Agriculture and storage at 6°C prior to export.

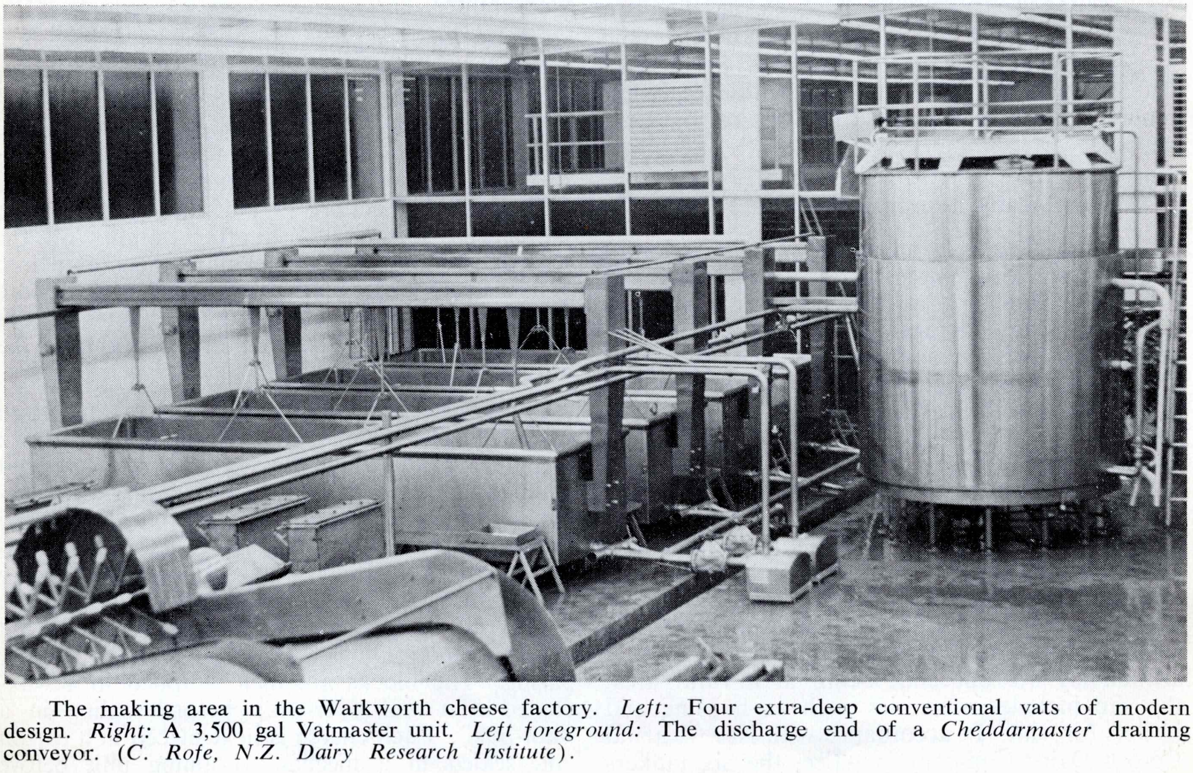
Factories Mechanized with Equipment Developed in New Zealand

Severe labour shortages in the rural areas of New Zealand coupled with a growing recognition that the conventional Cheddar-making process outlined above includes too much hard physical work led, in 1960, to the New Zealand Dairy Research Institute (with assistance from the Dairy Factory Mechanization Committee of the New Zealand Dairy Board), starting work on a comprehensive programme for mechanization of cheesemaking. The broad objectives of this research were to make cheesemaking a more attractive career and to reduce costs through improved efficiency (King, 1966). Although all facets of this work are not yet complete the effort has been a signal success, for some 20 New Zealand factories are already equipped with one or more of the resultant developments. Cheese factories in Australia, Great Britain and the United States are using these developments under a licensing arrangement and at least two internationally known companies have copied several key aspects of the New Zealand designs. So far as is known the basic design criterion of systems such as *Cheddarmaster, viz.* the retention and even extension of flexibility which is vital for successful cheesemaking under practical conditions, has not yet been copied, although this has been achieved in one instance by coupling a major *Cheddarmaster* component to another less flexible unit.

Warkworth

The Warkworth Branch of the Albertland Co-op. Dairy Company situated to the north of Auckland is an example of a new cheese factory specifically designed to take advantage of New Zealand developments in the mechanization of the cheesemaking process (Raines, 1970).

Like the Komakorau factory the one at Warkworth is attractively set out, but, because it is all mechanized, its floor area and staffing are less than that of Komakorau for double the output. The staffing of conventional factories is determined by 'the manning scale', an agreed formula which basically stipulates one man for each 900 gal of milk used in a cheese factory. In recognition of the improved working conditions in mechanized factories the Dairy Factory Workers' Union has



The making area in the Warkworth cheese factory. *Left:* Four extra-deep conventional vats of modern design. *Right:* A 3,500 gal Vatmaster unit. *Left foreground:* The discharge end of a *Cheddarmaster* draining conveyor. (*C. Rofe, N.Z. Dairy Research Institute*).

agreed to suspension of the scale, although each case is considered on its merits.

The difference between conventional and mechanized factories will be apparent from the following description of the equipment and process used at Warkworth.

Each day milk is delivered to the 25,000 gal silo at the factory by tankers based on Wellsford, a town 14 miles to the north. After pasteurization and clarification at 8,000 gph, the milk is pumped either into one of the three extra-deep rectangular vats of 2,200 gal capacity installed when the factory started up two years ago, or into one of the four 3,500 gal vertical, cylindrical (*Vatmaster*) vats installed more recently (Robertson, Bysouth and Harkness, 1969). A defined volume of starter is pumped into the pasteurized milk line while the vat is filling. As draining and cheddaring are carried out away from the vats, the conventional vats have four sets of fixed agitators but have no peg stirrers. In addition to an unusually large capacity the *Vatmaster* units are fully mechanized, the operations of cutting the coagulum, stirring, cooking, and draining of curd and whey being initiated by pushing the appropriate button. Each *Vatmaster* is self-contained and is enclosed to minimize contamination, particularly by bacteriophage, and to prevent loss of solution from the automatic clean-in-place cycle.

The cheesemaking process is similar to that followed at Komakorau until the time of running off the whey. At this time both the curd and whey are discharged from the vats or *Vatmaster* units and pumped to the draining conveyer at 10,000 gph, which is some 4,000 gph below the maximum of the *Cheddarmaster* system. *Cheddarmaster* (McGillivray *et al.*, 1966) provides for draining the whey, peg stirring, cheddaring either in large (12 cu. ft) manually operated boxes or in identical boxes mounted in groups of 12 in a mechanized arrangement, milling, mellowing after milling, automatic salting, stirring in of salt and either automatic weighing of curd into hoops and 'punching' down of curd, or transfer of curd to Large Hoops or the *Pressmaster* system of pressing. Filling hoppers are not required with this fully mechanized method of hoop filling. The *Cheddarmaster* equipment is run by one man (two where manual boxes are installed) apart from the man required to supply the system with empty hoops where these are used. Because the system consists of a number of independent units (one or two draining conveyors and physically separate cheddaring) it can easily cope with abnormal curd or starter behaviour and this flexibility is extended by the ability to vary the speed of either or both conveyors by a factor of six without a change in the pumping, or milling rate. Moreover, any of the four sets of stirrers per conveyor can be switched on or off at will and some can be reversed.

At Warkworth the *Cheddarmaster* system includes a draining conveyor, manual cheddaring boxes, a mill and a draining and salting conveyor. Salt is brought to the proportional salting unit from the remote salt store by a pneumatic conveying system. The salted and further mellowed curd is transferred to a bank of 12 Large Hoops (to be increased to 24 later), each capable of holding sufficient curd to make a 2,000 lb block of cheese after overnight vacuum pressing. Each Large Hoop (Robertson, 1967) eliminates the man-handling associated with 48 conventional hoops and by appropriate adjustment of the cutter, which divides the large mass into smaller units (usually 40 lb 2 oz) after pressing, cheese of almost uniform weight can be obtained without paring. Four perforated liners per Large Hoop replace 96 cheese cloths.

The 40 lb 2 oz cheese from the Large Hoops are check weighed and are wrapped and cartoned as described for the Komakorau factory. Pending the outcome of export trials last season it is hoped that the Warkworth factory will be changed from wrappers to the bag-in-a-carton approach devised as part of the *Pressmaster* system of automatic cheese pressing and packing (Robertson and Bysouth, 1969). Over 20,000 bags were used on an experimental basis at Warkworth last season.

The cartons are sealed in a carton gluing machine and open stacked on pallets prior to transfer to stowage racks in the curing room.

Belvedere

The Belvedere Branch of the Wairarapa Co-op. Dairy Company is an example of an existing factory which has been substantially mechanized.

By increasing the floor area by 30% and installing mechanized cheesemaking equipment the potential daily throughput of the factory was increased four-fold to 47,000 gpd without shift work.

Curd and whey is now made in six vats which have been deepened by 50%. As at Warkworth, when running acidity is reached, the vat contents are pumped to a *Cheddarmaster* draining conveyor but cheddaring is performed in 12-box mechanized units. After milling and salting on a second *Cheddarmaster* conveyor the curd is automatically weighed into 40 lb hoops. From the automatic filler the hoops are conveyed through a continuous automatic pre-press (Robertson and Bysouth, 1966) to a point where the cloths may conveniently be pulled up. After this the hoops go to one of two straight-through vacuum presses (Robertson and Bysouth, 1966) prior to overnight pressing in conventional presses. Subsequent operations are as described for Komakorau, except that the cartons of cheese are open stacked on pallets which are stowed on racks in the curing room.

Waihi

Another example of an existing factory which has been substantially mechanized is the Waihi Branch of the New Zealand Co-op. Dairy Company. The equipment and its mode of operation is the same as that at Belvedere except that the overnight presses are unusual in being arranged vertically. Devised by a New Zealand commercial firm these presses hold up to 26 hoops of cheese in a vertical column and are thus far more economical in floor space requirements than normal presses. Loading and unloading are fully automatic.

Factories Mechanized with Equipment Developed Overseas

Work on the mechanization of the cheesemaking process started in the United States, the United Kingdom and Australia before it did in New Zealand. Thus far the overseas developments have not been particularly successful, usually because of lack of flexibility, although *Cheesemaker 3*, the Australian-developed equipment for the milling, salting and hooping of cheese, is a noteworthy exception. Several *Cheesemaker 3* units are installed in New Zealand factories.

Only two New Zealand factories are equipped with reasonably comprehensive mechanized systems developed overseas. They are the Ngaire Co-op. Dairy Company and the Opunake Co-op. Dairy Company.

Ngaire

The Ngaire cheese factory in central Taranaki is the only factory in the world equipped with the Mark I version of *Cheesemaker 2*, devised by Czulak and his colleagues in Australia (Czulak and Freeman, 1967). A substantially changed Mark II version is installed in an Australian factory.

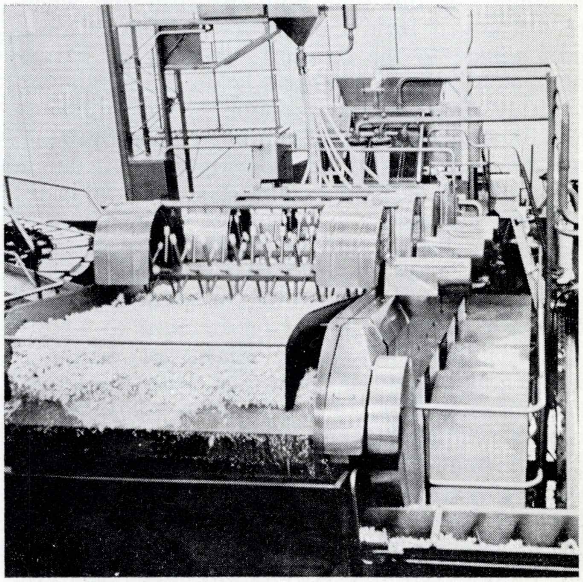
Ten conventional vats of 1,000 gal working capacity are used at Ngaire for processing up to 26,000 gal milk each day. Because the hourly throughput of *Cheesemaker 2* is relatively low a pasteurizing rate of only 4,000 gph is used. Curd and whey are pumped to the draining compartment of *Cheesemaker 2* where it is stirred for 10-12 min before the floor of the draining vat is opened to discharge its contents into an endless chain of L-shaped shelves arranged to form a series of troughs to hold the cheese while it cheddars. Partway through the system the partially cheddared blocks are automatically transferred to another endless chain of troughs with one movable side. By applying mechanical pressure to this side the cheese is forced to flow, thus simulating the flow which occurs on the vat floor in the conventional process.

About 1 h 35 min after the curd drops into the cheddaring system the blocks of cheddared curd are divided longitudinally and discharged into the mill of *Cheesemaker 3*. The milled curd is continuously weighed and salted on a weight basis as it enters a small mixing trommel. It is then automatically weighed into hoops fitted with filling hoppers.

The Ngaire Company uses its own design of holding platform (to facilitate salt penetration), pre-press and vacuum press (Lawrence, 1969). Overnight pressing and final packing of the cheese are as described for Komakorau.

Opunake

Opunake is on the southern coast of Taranaki. The factory was extended a few years ago and has recently been equipped with a *Cheddarmaster*



Milled and salted curd leaving a *Cheddarmaster* draining conveyor in a highly mechanized cheese factory. (*R. Bysouth, N.Z. Dairy Research Institute*).

draining conveyor to serve as a pre-feed to increase the capacity of the *Lact-o-Matic* unit which was installed at the same time. *Lact-o-Matic* was developed by Vyhnalek and his associates in Australia (Wallace, 1968). The hourly capacity of *Lact-o-Matic* matches a pasteurization rate of about 3,000 gph with New Zealand cheesemilk. This is rather too small for many New Zealand cheese factories although it is clear from experience thus far at Opunake that, when coupled to a *Cheddarmaster* conveyor, it will suit a pasteurization rate of 5,000 gph.

At Opunake conventional vats are used until the running acidity is reached. Curd and whey are then pumped to the *Cheddarmaster* conveyor for draining. The curd is then briefly resuspended in whey to facilitate transfer to the draining screen of *Lact-o-Matic*. From the screen the curd enters a short, vertical fusing tower and is discharged from it ½-¾ h later through a kidney-shaped opening onto a slow-moving "cheddaring" conveyor which is wide enough to permit lateral flow as the band of fused curd moves to a mill. After milling, the curd is automatically salted, tumbled in a long "conditioning" tube and automatically weighed into hoops fitted with filling hoppers. The subsequent steps in the process, including pre-pressing and vacuum pressing, are the same as those described for Belvedere.

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MILK POWDERS

By W. B. SANDERSON

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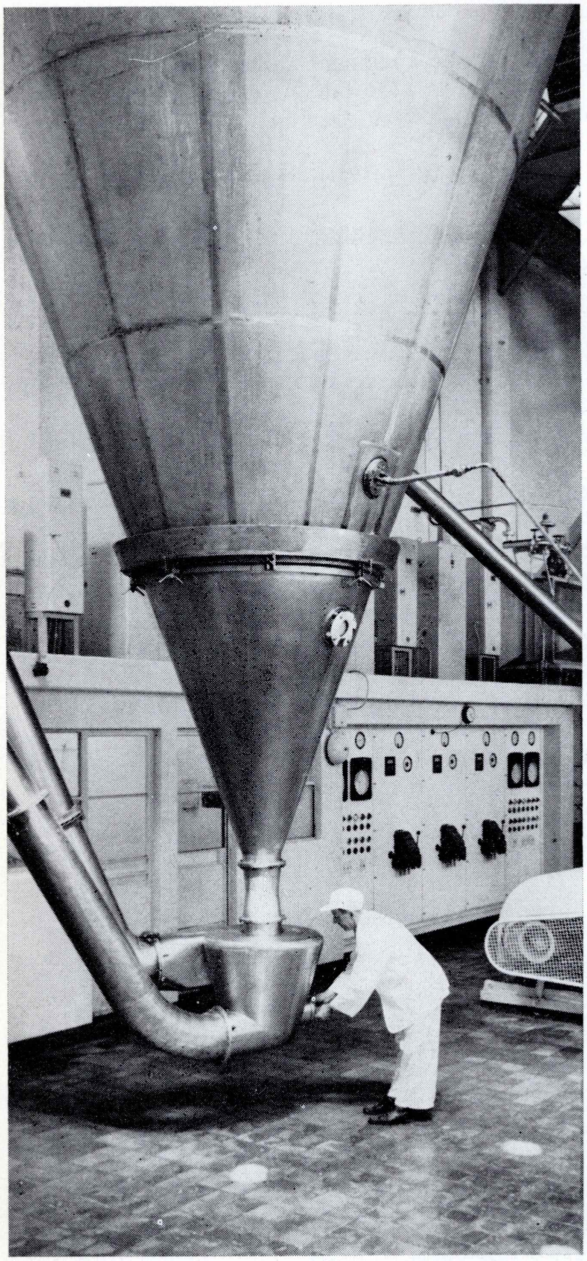
The production of milk powders by the major dairying countries of the world has increased at a rate considerably faster than that of any other dairy product. World production has now reached over three million tons, which represents an increase of more than 45% over the past five years (N.Z. Dairy Board, 1969).

The increase in production within New Zealand during this same period has been even more spectacular, from about 100,000 tons in 1964/65, an increase of approximately 60%. Most of this increase has been in spray dried skim milk powder which, as the following approximate production figures for the 1968/69 season show, is the major milk powder product produced in New Zealand:

	Spray dried powder (tons)	**Roller dried powder (tons)**	**Total (tons)**
Skim milk powder	130,000	4,000	134,000
Buttermilk powder	17,000	6,000	23,000
Whole milk powder	11,500	500*	12,000
Blended full-cream powder			
Baby foods			
Whey powders	2,000	—	2,000
		Total	171,000

* Plus a significant quantity of baby foods produced by Glaxo Laboratories (NZ) Ltd, one of the few proprietary dairy companies in New Zealand.

While New Zealand is only the fifth largest producer of milk powder in the world it is the



Drying flume of one of the earlier spray driers installed in New Zealand.

second largest exporter. Almost 80% of the total production of milk powder is exported, primarily to East Asian countries, a further indication of the importance of export markets to the New Zealand dairy industry and the country's economy.

A major factor associated with the rapid growth in the export of milk powders from New Zealand has been the establishment of a number of recombining plants overseas. The supply of both spray dried skim milk and buttermilk powders to these recombining plants producing fluid milk, sweetened condensed milk, and evaporated milk, makes up a significant amount of New Zealand's total export of milk powders.

With the rapid growth of the milk powder industry has come a change in the attitude towards production. No longer is milk simply evaporated and spray dried to produce whatever powder happens to result. The move has been towards the specific production of powders designed to meet customers' requirements. This has led to the development of a considerable number of "specification powders", each tailor-made to the requirements of individual customers. Strict production and quality control has changed milk powder manufacture into one of the most specialized sectors of the industry today.

Skim Milk Powder

Almost all of the spray dried skim milk powder produced in New Zealand is now made to meet either: (i) a heat classification based on the amount of undenatured whey protein nitrogen in the powder or (ii) a heat stability requirement. This has arisen because the purposes to which milk powders are being put by individual customers require the raw skim milk to be subjected to specific heat treatments during manufacture.

Medium-heat skim milk powders for use in the manufacture of recombined sweetened condensed milk are being made to meet undenatured whey protein nitrogen values with very narrow ranges, frequently within a WPNI tolerance of not more than 1.0 mg/g. In addition to this a number of milk powder batches are further screened for suitability by pilot-scale manufacture of recombined sweetened condensed milk using manufacturing conditions as close as possible to those of the prospective customer. The manufacture of heat-stable skim milk powder to meet the requirements necessary for the production of recombined evaporated milk, particularly to the more difficult British Standard composition of 22% SNF and 9% fat, requires equally strict production and quality control.

While heat classification is an important factor in the manufacture of many product specifications, solubility index, bulk density, moisture, and microbiological quality must also be strictly controlled to meet individual customer requirements. High quality raw milk is of the utmost importance, since not only must the total microbiological quality of the powder be carefully controlled, but exacting specifications have also been set for various specific types of micro-organisms, such as yeasts and moulds, coliforms, thermodurics, and staphylococci. As a result of these microbiological requirements, raw milk quality in New Zealand is reaching exceptionally high standards. The routine testing of raw milks from the farms has been the subject of a considerable number of investigations (Crawley and Twomey, 1969; Twomey, Crawley and Derrick, 1969; Twomey *et al.*, 1969; Lawrence *et al.*, 1969), and a number of quality tests, in addition to the methylene blue reductase test, are now being used by many dairy companies. Some companies, such as the Rangitaiki Plains Dairy Co., have successfully established special premium milk schemes to encourage the production of even higher quality raw milk (Thorpe, 1970).

In addition to the powders used in recombined milk products, specification milk powders are now being manufactured for use in a number of other products, such as bakery goods, ice cream, chocolate, and recombined cheese.

Buttermilk Powder

Buttermilk powder, although produced on a much lesser scale than skim milk powder, is still a valuable addition to the country's milk powder exports. Spray dried buttermilk has become an important component in the manufacture of recombined milks. Since the milkfat used in recombining is either unsalted sweet-cream butter or anhydrous milkfat, the replacement of some of the milk solids normally supplied by the skim milk powder with buttermilk powder returns the solids, which were lost in the manufacture of butter or milkfat, into the recombined milk products. The inclusion of some buttermilk powder improves the fullness of flavour and, in addition, supplies some milkfat at a price approximately one-third of the cost of the same fat when purchased as butter.

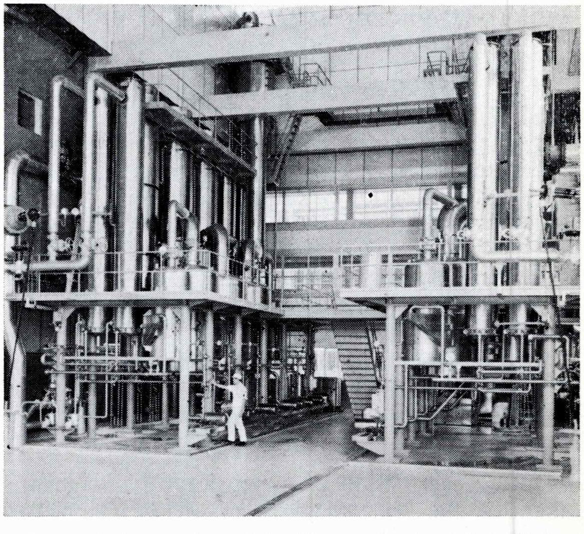
Spray dried buttermilk powder is frequently manufactured in the same plants as are producing skim milk powder and is subjected to equally stringent quality control. Although it is not possible to manufacture this type of powder to a wide range of heat classifications owing to the fairly high heat treatment received by the cream during buttermaking, it is still produced to meet a variety of customer specifications ranging from high quality stock foods to "tailor-made" powders for recombined milks, bakery goods, and ice cream.

Whole Milk Powder

Whole milk powder and related powders, such as baby foods and blended full-cream milk powders, make up a relatively small proportion of annual production, but remain an important aspect of the country's milk powder production. The production of spray dried powders in this category can be divided almost equally between standard whole milk powder and baby food powders which are based on whole milk powder. Almost all of the blended full-cream milk powder, which is manufactured from a blend of cream, skim milk and/or buttermilk, is produced by roller drying. In addition to this Glaxo Laboratories (NZ) Ltd produce a significant quantity of roller dried baby foods. A small quantity of spray dried rennet casein whey powder is also produced annually.

History of Powder Industry

The history of the milk powder industry in New Zealand dates back to the turn of the century. The first milk powder factory was built in 1904 by the New Zealand firm of Joseph Nathan and Co. for the manufacture of roller dried milk powders, and in 1906 they registered their product under the name of "Glaxo". In 1936 the Company changed its name to Glaxo Laboratories (NZ) Ltd and is today still the main manufacturer of roller dried baby foods in New Zealand.



Two of the modern thin-film evaporators installed at the Te Rapa Branch of the New Zealand Co-op. Dairy Co. (*National Publicity Studios, Wellington*).

The first spray dried milk powder factory in New Zealand, and in fact one of the first in the world, was built in the Waikato district at Waharoa in 1920 for the Zealandia Milk Co., a subsidiary of what is now the New Zealand Co-op. Dairy Co. Two years later the same Company built two more spray drying factories in the Waikato at Waitoa and Te Awamutu. Each of these factories was equipped with Grey Jensen spray driers, giving a total of 11 units. The total solids in the milk fed to the driers was increased by means of "wet collectors" and the capacity of the driers ranged from 500-600 lb powder per hour.

Apart from the installation of roller driers for a number of the butter factories in New Zealand to allow them to dry buttermilk, very little expansion took place in the milk powder industry until the 1950-55 period. At this time a number of new companies entered into the production of spray dried milk powders with the installation of a further 10 plants, most of which had capacities ranging from 1,500-3,000 lb powder per hour. At the same time the original Grey Jensen driers at Waharoa, Waitoa and Te Awamutu were extensively modified and Buflovak evaporators were installed. This more than quadrupled the capacity of these factories. Most of the new spray driers installed during this period were either Grey Jensens or were of the horizontal box-type, although several European driers, such as the Niro and Luwa, were installed for the first time. With this increase in manufacturing capacity, the annual production of milk powders rose from little more than 10,000 tons during the early 1940s to more than 50,000 tons by 1957.

Modern Drying Equipment

By far the greatest advance, both in production and in technology, however, has taken place during the last decade. Spray drying plants were installed with capacities of from 1,500 lb powder per hour to the very large units at the Te Rapa Branch of the New Zealand Co-op. Dairy Co. and at Rangitaiki Plains Dairy Co., each of which has a capacity approaching 6,000 lb powder per hour. A total of 20 additional spray drying units installed during this period more than trebled the annual production of milk powder in New Zealand.

During this period of expansion advantage was taken of the technological advances which had occurred in drying equipment, particularly in the design of evaporators. More versatile milk preheating equipment was installed, and the older type of recirculating double- and triple-effect evaporators were replaced by triple- and quadruple-effect thin-film evaporators equipped with thermorecompression units for more efficient utilization of steam. These evaporators caused less damage to the milk and allowed evaporation of the concentrate to higher levels of total solids and thus markedly improved the efficiency of spray drying.

The majority of spray driers purchased during this period were of European design. It is of interest to note the change in the type of driers installed in New Zealand during the growth of the milk powder industry, from the American-designed driers using pressure atomization, to a predominance of European-designed driers equipped with centrifugal disc atomization. The greater efficiency in milk powder production resulting from improved evaporator design and the concentration of milk to 50% total solids before spray drying has significantly reduced fuel and power costs, a major item in the total manufacturing costs of powders (Dennis, 1967).

The increase in viscosity associated with greater concentrations appears to be a limiting factor in attempting to further increase the concentration of the milk. Recent research in New Zealand on various aspects of improving spray drying efficiency (King, 1967; King, Sanderson and Baucke, 1969) has indicated that the solubility of the powder produced becomes severely affected when the concentrate viscosity is high. It seems likely that with present-day spray drier designs the maximum concentrate total solids permitting high quality powder production may be in the vicinity of 52-54%.

Packaging

Because of the large daily production of the individual drying plants, the storage and packaging of milk powder has become an increasingly important aspect of the industry. Over the past few years a number of companies have installed powder storage and blending silos, so that a single day's make can be stored and blended to a uniform quality before being packed the following day. Under this scheme, milk powder is pneumatically conveyed into one or more of a series of silos where it can be recycled or blended with powder from other silos during transport to a spare silo before final transfer to the packing silo.

Milk powder is usually packaged into 50 or 56 lb multiwall kraft bags fitted with an inner polythene liner bag. Some powders, for direct consumer consumption in New Zealand, and a

New Zealand dairy industry has lived through one of the most difficult periods in its entire trading history.

Yet during this decade of intense competition on the international markets, characterized by price-cutting, often carried to ludicrous lengths, this industry has maintained steady growth and continued to develop and extend its markets. In 1960 we exported 340,000 tons of products in all forms, valued at $150 million, mainly to the United Kingdom. Last year we sold and shipped 520,000 tons of products to 94 markets, to a value of $230 million. Approximately 47% of this tonnage was sold to markets outside the United Kingdom. Most of the high-value products, the butter and cheese, continued to be sold in the United Kingdom, and for this reason the British market provided 70% of our export income.

The methods employed to market our goods are in principle no different from the ordinary commonsense methods in general use in many successful commercial enterprises. Though we sell directly to processing firms in some cases, the bulk of our sales is made through a network of agents extending throughout the world.

NEW ZEALAND DAIRY PRO
MENU

Youth at Expo 70. Japanese teenagers by the thousands have visited the New Zealand Dairy Board's two shops where they buy and enjoy milkshakes and ice creams, two novelties which have established themselves firmly with the younger generation and the older.

Representing us in close on 100 markets, we have rather more than 150 agents who work exclusively for New Zealand in the dairy products field. In a number of markets, we are closely associated in various ways with local companies marketing, processing, or packing our products, as in Hong Kong, Thailand, Trinidad, Jamaica, and Barbados. In the United Kingdom we have our own representatives and our own offices, as we do also in Japan. In the United States we have research and product development laboratories, financed and operated in partnership with our agents.

We visit all our agents and many buyers as often as possible, usually sending out delegations of two or three representatives, typically including commercial and technical staff and sometimes research advisers. The provision of highly developed technical services to our agents and clients has become an important feature of our marketing operations in the past decade. In this way we assist clients with technical advice, and what is of increasing importance, we are enabled to develop ideas for new products or variants of existing products, which either meet present needs more precisely, or create opportunities for a new branch of trade.

It is essential that the technical information amassed in this way should be conveyed to research scientists, and also to the managers and technical personnel of the manufacturing companies. They must be kept abreast of the rapidly changing market needs. The dairy companies remain sovereign powers, each in its own right. The board of directors of each company decides what product or products will be manufactured. Thus each company must be kept in the picture so that it will be prepared to respond affirmatively to the calls constantly made on companies to manufacture new products, or to vary specifications or to pack in new ways, and so on.

As we are dealing in perishable foods, the maintenance of quality at all stages of production is vital. A glance at the past shows that over a long period our industry has paid constant attention to the need for quality. An independent authority, the Dairy Division of the Department of Agriculture, is responsible for laying down and enforcing standards of hygiene on the farms, in transport, and in the factories. The Department is also responsible for grading New Zealand export dairy products. The Government grading system was introduced by New Zealand in 1894 and has since been adopted by most other dairy exporting nations. It provides an assessment of quality which is completely independent of the industry and is accepted by buyers all over the world. Indeed, the grade note is the basis on which all our sales are made.

Of great significance to this country is the need for improved access to markets. A strong tendency has developed in the past 20 years toward agricultural protectionism in many countries. We, who must sell overseas in various

PRODUCTS AND MARKETS

MARKETING NEW ZEALAND DAIRY PRODUCTS

By N. O. JONES
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Success in the marketing of dairy products, as of other commodities, depends on the seller's ability to place the right product at the right price at the right place at the right time. It is not an art; it is a science. Though luck plays some part in the total result, the chief determinant of the outcome is the skill with which the work of the milk producers, the manufacturers, the graders and quality controllers, the research scientists, the technical advisers, the salesmen, the administrators, the storage and transport operators, is welded to produce a result that the buyer overseas considers is better than one's competitors can offer.

The New Zealand dairy industry has developed its institutions and procedures with the needs of overseas markets uppermost in its mind, for the great bulk of the milk produced is used in the manufacture of export products. For nearly 35 years its goods have been sold through a central marketing organization, now much the largest of its kind in the world. Co-operation has led to the initiation of industry-wide research and development programmes and technical advisory services, and to the integration of all these activities with manufacturing and marketing. Marketing is merely the final link in the chain of co-ordinated effort by workers in many fields.

There is not the slightest doubt that marketing of dairy products will become even more complex as time goes on. Success will belong to those who can supply products in the traditional form to large markets, and who can also develop new products, or vary existing ones to suit the palates and preferences of persons with no great tradition of dairy products' consumption behind them, and what is no less important, who can take advantage of opportunities opening up all over the world for the formulation of entirely new food products.

Gone are the days when the dairy industry of this country depended for its living on one type of butter, one type and pack of cheese, together with small quantities of skim milk powder and casein, then known as by-products. Today we are selling milk in 100 different forms: we are getting closer to customers with highly sophisticated requirements and working with them in the technical and scientific fields to develop new products. The horizon is crowded with unsolved problems; but it always has been. What is new in the outlook today is the promise of new and expanding markets for milk products if we pursue with resolution all the opportunities that are apparent.

The New Zealand dairy industry has had to increase its efficiency in the past 10 years to withstand the onslaught of low prices brought about by dumping. The dairy product exports of all this country's competitors are subsidized by their Governments and frequently are offered for export at a fraction of the prices which are considered to represent fair market values in the country of origin. Unlike any other dairy-exporting country, New Zealand has had to live on the actual proceeds of today's reduced values. As a consequence, in the past 10 years, the

New Zealand Cheddar
Master of Tasty Surprises
ALL STAFF WANTED ADV.3815
Appletons
complete
IN
IN

New Zealand is the largest advertiser of dairy produce in the United Kingdom. Posters are used in all the main cities (*Colin Tait Studios, London*).

filtered, re-evaporated, and crystallized before being reseparated, washed, dried, and milled, to yield edible and pharmaceutical grades of lactose.

The mother liquor separated from the lactose and containing the balance of whey solids is either sold direct as a liquid, mainly to farmers close to the processing factories for stock feed, or is used in the manufacture of solid animal feeds which are sold throughout New Zealand.

The Company's larger plant at Kapuni has recently been extensively modernized with the installation of high-efficiency evaporators and associated equipment, to give a highly efficient lactose processing unit. The Company is also noted for its extremely high standard of technical competence.

The Lactose Company is the only company manufacturing lactose in New Zealand. Its current production is about 9,000 tons per annum, and of this about 90% is exported, largely to markets surrounding the Pacific and Indian Oceans.

Glaxo Laboratories (N.Z.) Ltd. is another proprietary company manufacturing a variety of dairy products. This firm, which is a member of the largest British-owned pharmaceutical group, occupies a unique position in the New Zealand dairy industry. At one and the same time it is a manufacturer of bulk milk powder, marketing its own branded lines of baby foods and other nutritional products, and also makes antibiotics, vaccines, and other remedies for the control and prevention of disease in dairy herds.

Joseph Nathan & Co. the Wellington firm which founded Glaxo, first started the manufacture of milk powder at Bunnythorpe near Palmerston North in 1905. Three years later it launched "Glaxo — the food that builds bonny babies" on the English market and this product soon gained a high reputation for its quality and nutritional excellence. After the First World War, when the importance of fortifying infant foods was realized, Glaxo was one of the first companies to add vitamin D and iron to its product, and this led the Company into the wider field of pharmaceutical manufacture.

The greatest impetus to this side of Glaxo's activities came with the outbreak of World War Two and the founding of the British antibiotic industry. Glaxo pioneered the manufacture of penicillin and now makes very large quantities of this and other antibiotics, which are finding increasing veterinary use in the treatment of mastitis and other infections of cattle.

Although probably now better known to the veterinary and medical professions for its achievements in pharmaceutical and biological research and production, Glaxo has nevertheless remained active in the production of baby foods and other milk-based products. Examples of these are *Complan,* a complete food, and *Farax,* a three-cereal food; *Fostermilk,* an emergency lamb food, was developed and produced in New Zealand; and more recently a single-formula food, *Golden Glaxo,* has been produced specially for babies in the Pacific islands, and is finding a wide and rapidly expanding market throughout the South Pacific.

Glaxo's own production of milk products is by the roller drying process at their factory at Bunnythorpe, but the Company also buys substantial tonnages of other milk products from the New Zealand Dairy Board, and is currently involved in the erection of a new $3 million spray drying factory on their present site.

Another proprietary company operating in New Zealand is the Nestle Company (New Zealand) Limited. This Company has had a long association with the New Zealand dairy industry, originally manufacturing condensed milk at Underwood Condensery, Invercargill, where fresh milk was received from approximately 300 suppliers. Large quantities of sweetened condensed milk were manufactured and exported, the principal market being Malaya.

Owing to the declining milk production in Southland it became necessary in 1964 to transfer these operations to a new factory, Cambria Park, just south of Auckland, where milk is now received from the Waikato district in concentrated form delivered by tanker and trailer. Milk products currently manufactured at Cambria Park are sweetened condensed milk, evaporated milk, coffee and milk, reduced cream, and *Milo* tonic food. The '*Highlander*' brand was first registered in 1901 and 14 oz tins of sweetened condensed milk have been marketed in New Zealand under this label for the past 70 years.

Other proprietary companies, notably in the ice cream and processed cheese fields, manufacture for the local market. These companies enjoy a close association with the dairy industry as a whole and also manufacture specialty products as required for export in conjunction with the New Zealand Dairy Board.

portable dairy products the New Zealand dairy industry has developed extremely versatile plant. This is particularly so in the multi-product companies mentioned above, but also applies to some extent in a large number of the traditional factories. In the multi-product factories casein may be precipitated in one plant, converted to sodium caseinate in another plant, and spray dried in the spray drying plant. Cheese whey may be spray dried in the spray drying plant or may be blended with skim milk powder to make special blends. This has allowed the ready development of the newer and more highly processed products requiring more complex manufacturing procedures. Butter factories are now being equipped to make anhydrous milkfat on site, in place of the old traditional method of manufacturing at a plant near a large port.

Frozen cream is another example of the industry's versatility. An unique marketing opportunity for the product became available in the United States. Because a New Zealand company was able to meet the very strict specifications set for this product we have developed a significant export trade in this competitive market.

The dairy industry is now moving rapidly into close association with the food industry and many of the products now being produced are specifically formulated for use in various food processing industries. Pharmaceutical and dietary products are now being made straight from fresh, high quality, raw milk into the final product, obviating the expensive reprocessing that was necessary in the past. Facilities are now being increasingly provided to allow for the incorporation of other non-dairy products into these blends and the most complex formulations can now be produced directly from milk.

Conclusion

The New Zealand dairy industry has become the most efficient in the world. This has been brought about by the sheer economic necessity to survive in the face of ruthless competition from dumped produce and the distance from the marketplace. It is extremely versatile now, and in the next decade will become even more so. This versatility will be its strength for the future, and the increasing facility with which the industry is able to cope with rapidly changing market requirements will guarantee it the continuing role of the largest exporter of dairy produce in the world.

PROPRIETARY MANUFACTURERS

By W. A. McGILLIVRAY

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In the foregoing articles on butter, cheese, casein, and milk powders, reference has been made to the numerous variants of these basic dairy products and to a variety of related products which are now being manufactured. Clearly, this diversification into new products and process modifications will, to an ever-increasing extent, be the pattern of dairy manufacture in New Zealand in the future, with the emphasis no longer on a few simple products, but on a wide variety of items, each tailor-made to the requirements of individual customers or particular end uses.

This development will continue to take place within the framework of the co-operative system and the unified marketing organization which are such essential features of the New Zealand dairy industry. Nevertheless, an account of the industry today would be incomplete without some reference to the few proprietary dairy companies operating in New Zealand and producing a variety of specialty products.

Closely integrated with co-operative cheese companies in Taranaki and Southland is the Lactose Company of New Zealand Limited, a subsidiary of the British Unigate group. The Lactose Company contracts to purchase whey from the cheese companies and currently processes whey from over 40% of the cheese manufactured in New Zealand. This totals between 60 and 70 million gallons annually, and is converted into lactose and animal foods in the Company's two factories situated at Kapuni in Taranaki and Edendale in Southland. The whey from the cheese factories is carted by tanker to the central processing units where it is evaporated under vacuum to about one-twelfth of its original volume. It is then seeded, cooled, and crystallized for about 14 days before the lactose is separated from the mother liquor by continuous centrifuges. The lactose is then dispersed in cold water and is reseparated when it is either: (a) dried and milled, to yield a technical grade of lactose; or (b) dissolved in hot water, treated,

Tanker collection is one of the major features of New Zealand's versatile dairying industry. Here a typical 22,000 lb tanker with 22,000 lb trailer is unloading milk into a silo at the Rangitaiki Plains Dairy Co.—a good example of a multi-product factory capable of making a wide range of different dairy products from milk. (*Snow Photography Ltd, Whakatane*).

Seasonal Nature of Production

Because of the seasonal nature of production in New Zealand, factories have to have sufficient plant capacity to cope with the peak milk intake occurring over the months of October, November and December. This means that they do have a large amount of unused capacity in the months preceding and following these peak periods. This unused capacity is another major factor contributing to the versatility of the New Zealand dairy industry.

The seasonal nature of our dairy industry means that milk composition is changing on a regular seasonal pattern. This enables the industry to select milk of the most favourable biochemical composition to suit a particular product.

Co-operation Between Organizations

A further feature of strength in the New Zealand dairy industry is the close co-operation between the central marketing organization, the New Zealand Dairy Board, the specialist institute, the New Zealand Dairy Research Institute, and Government, which is responsible for quality control and checking. There is also very close liaison with the Government research institutes operated by the Department of Scientific and Industrial Research and the Department of Agriculture. A close liaison with all universities, but particularly with Massey University and its Department of Food Technology, also exists.

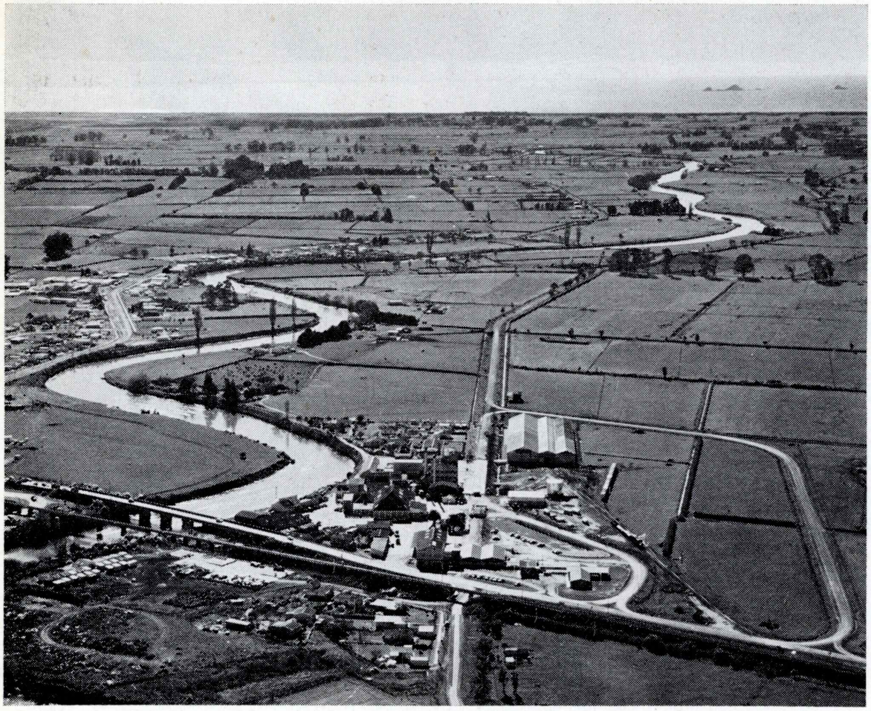
Another feature of the New Zealand dairy industry is the fact that all companies are co-operative. Although there is intense competition between companies to see who can get the highest payout for their farmer shareholders, there is a very free flow of information between companies. This close co-ordination of marketing, research, teaching and production is an important factor in giving New Zealand an extremely versatile industry.

Multi-Purpose Factories

A new trend in New Zealand dairy companies is to have multi-product factories on the one site, which does significantly increase efficiency. A typical multi-product factory would include on the one site: butter plant, roller drying plant, evaporating and spray drying plant, and casein precipitating washing and drying plant, together with all ancillary services, representing an investment ranging from $10,000,000 to $20,000,000, including milk tankers, farm vats, etc. Under this system all milk comes to a central site and the company can divert milk merely by a pipeline from one product to another with comparative simplicity. Today these multi-product factories handle up to 3,000,000 lb per day and larger units are planned.

Versatility in Plant

In converting the raw material, milk, to ex-



An aerial view of the Rangitaiki Plains showing a typical compact dairy farming area with the Rangitaiki Plains Dairy Company's factory complex in the foreground. At the peak of the season 1,500,000 lb milk per day is collected within an 8-mile radius of the factory. (*Snow Photography Ltd, Whakatane*).

of our industry's versatility. The change from the old system of farmers delivering milk in cans to the factory to tanker collection commenced some 20 years ago with the introduction of farm vats of 1,800-3,200 lb capacity, uninsulated and non-refrigerated. Milk was collected from these vats twice a day after each milking by tankers with capacities of 8,000-15,000 lb. This system is now rapidly being superseded by newer systems involving the installation of refrigerated vats of 5,000-20,000 lb capacity which hold the milk at temperatures from 6 to 8°C. This has allowed collection on a daily and skip-a-day basis to be instituted whilst maintaining excellent bacteriological quality. Tankers too increased in size and now units of 22,000 lb, often towing trailers of similar capacity, are in regular use. Some single units of 30,000 lb have been designed with multiple axles to cope with maximum axle loadings on rural roads. The large units collect direct from the farm dairy.

These big units have allowed the economic collection of milk over large areas. As a result many of the small local dairy factories, which were in many cases located only a few miles apart, have amalgamated into larger units covering a radius of up to perhaps 50 miles. These large tanker units also allow economic transport of milk from one factory to another or from farm to several alternative factories. The use of these units for direct haulage from the farm means that there has been no need to develop intermediate separating or bulking stations as is common in many other countries.

Concentration of Dairying Areas

A feature of the New Zealand dairy industry is the extreme concentration of dairy farmers in the major dairying districts of the Auckland and Taranaki provinces. In these districts large areas are devoted almost completely to dairying, and large dairy factories have a tremendous gallonage of milk within a very small radius of the factory. A daily production of 1,200, 000 lb per day from farms within an eight-mile radius would not be unusual. New Zealand's largest dairy company, operating several factories in the Waikato, has an intake at the peak of the season of 10,000,000 lb per day within a radius of 40 miles. This concentration has also allowed the development of specialist plants only economic on a large scale. The lactose plant in Taranaki collects 3,000,000 lb of whey per day from upwards of 50 cheese factories and processes this in one central unit. At present, research emphasis is being directed to the development of an ever-widening range of protein products, particularly from whey, and it has rapidly become apparent that only extremely large-scale production will enable these products to be produced economically.

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VERSATILITY IN DAIRY MANUFACTURE

By R. A. DENNIS

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In writing about the versatility in dairy manufacture it is necessary to stress that the dairy industry in New Zealand is export orientated. This fact has been made abundantly clear by the previous papers. The New Zealand economy depends tremendously on the dairy industry which has returned approximately one-third of our export income for many years and will continue to contribute a minimum of 25% of the export income for the next decade. In the foreseeable future of New Zealand the dairy industry will continue to play a major role in the economy and standard of living of this country. Because our veritable livelihood depends on an efficient industry, we have, through necessity, had to become extremely versatile.

As is shown in the following table of prices received by dairy farmers in various countries in 1968/69, New Zealand has developed a remarkably efficient dairy industry with the lowest cost of milk in the world.

Country	**Cents/Gal (Imp)** (Adjusted to standard of 3.7% fat content)
United States	48.2c
Italy (North)	44.9c
Netherlands	40.1c
Canada	39.6c
Belgium	39.2c
France	38.0c
West Germany	37.7c
Austria	35.5c
England & Wales	35.2c
Denmark	28.8c
Australia	20.9c
New Zealand	12.3c

This efficiency, while aided by a generous climate, has been necessitated by the distance from its main markets and continual competition from 'dumped' dairy products from some of the high-cost production countries getting rid of their surpluses.

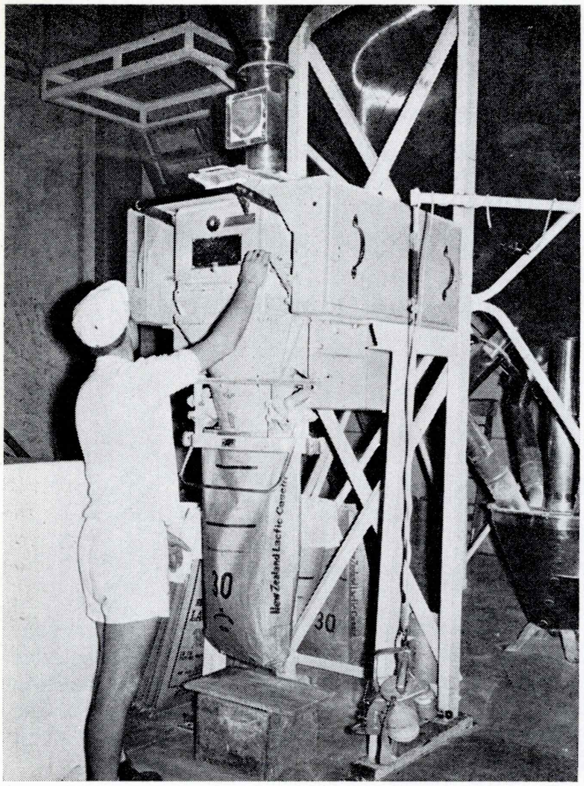
Ten years ago New Zealand manufactured a very small number of dairy products. Principally there were four products — butter, cheese, casein, and skim milk powder. Now New Zealand has 100 different export products packed in several hundred different forms. It is important to realize that these products exclude all town milk and ice cream products that are traditional to dairy industries in most other countries.

Raw Material

In examining the versatility of our dairy industry we start with that miracle raw material, milk, and from this produce a wide range of dairy products. The strength of the New Zealand dairy industry lies in its ability to convert this raw material quickly and efficiently into the most profitable export products offering at the time. Considerable research has been carried out in New Zealand in upgrading the quality of this raw material to make sure that the starting point is the best in the world. Recent researches and commercial trials have established beyond doubt that New Zealand can produce milk of unequalled quality, and with this milk can manufacture high quality dairy products.

Tanker Collection Systems

Tanker collection, together with the concentration of dairying areas, forms the cornerstone



Bagging casein in a New Zealand factory.

This process eliminated the necessity for large holding tanks in the factory and at the time allowed rather better control of the process. Some sulphuric casein is manufactured, but the overall costs are similar to those for lactic casein manufacture and the quality of the latter product has improved to the stage where the manufacture of sulphuric casein cannot be justified on quality grounds. Sulphuric casein whey is not as satisfactory as lactic whey for pig feeding and other uses.

Another variant developed at the Rangitaiki Plains Dairy Company (Oetiker, 1960) was to ferment the casein whey using a lactobacillus in the presence of lime when calcium lactate was formed. On completion of the fermentation, impure lactic acid was liberated by the addition of sulphuric acid and consequent precipitation of the calcium sulphate. This acid was then used for casein manufacture.

Related Products

Experimental work in New Zealand has been proceeding in recent years on the production of various co-precipitates and on other forms of casein, such as caseinates and spray dried caseins. Considerable information and experience has been acquired on the manufacutre of these products, and increasing tonnages of good quality sodium caseinate and other specialty products are now being made.

Quality and Uses

Acid caseins have traditionally been used as adhesives in the glue, paint, and particularly the paper-coating industries. In consequence, considerable work has been done in New Zealand on properties of casein of industrial significance, especially viscosity and adhesive strength (Dolby, 1961, 1964; Southward and Dolby, 1968). Casein is still important in the paper-coating industries but its use directly in foods has expanded remarkably in recent years and has led to the necessity for producing edible grades of casein. This has been accomplished in New Zealand by the establishment of quality incentive payments based on bacteriological and chemical analyses, and by regulations controlling environmental conditions and requiring all surfaces in contact with milk or curd to be of stainless steel construction (Newport, 1967). The great bulk of acid casein produced today in New Zealand complies with these edible quality standards.

Another recent development of considerable significance has been the swing from raw to pasteurized milk for casein manufacture. This has little effect on the bacteriological quality of casein, since investigations have shown that most of the control over this occurs during the washing and drying stages. Pasteurization does, however, have an effect on the ease of manufacture and the control of the growth of the starter organisms and, consequently, is being widely adopted for edible casein manufacture (Evans, 1970; King, Weal and Southward, 1970).

Caseinmaking in New Zealand is now a highly sophisticated operation carried out in plants well up to the standards expected in a food-processing industry. At the same time, as a consequence of the significant technical developments which have taken place, the economies of scale and the types of equipment used, costs of manufacture of casein in New Zealand are relatively low. Efforts continue to effect further economies in manufacture, to continually improve quality, and to extend the range of protein products available.

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blown from below through both trays in series and passes off from the top of the drier into a collection system. The partly dried casein is then conveyed pneumatically to a second machine which is similar, except that it utilizes four drying trays one above the other.

The casein passes from this four-decker drier to tempering bins in which several tons are accumulated and kept agitated by constant conveying. This tempering process helps to cool the casein, to mix it, and to prevent it from sticking. After an interval, usually of 24 h, the casein is ground in a roller mill, sieved in plan sifters to 30, 60 and 80 mesh sizes, and passed through a series of bagging-off bins. The 30 mesh bin, and sometimes the others also, is arranged for blending the casein. This is achieved by a bin transfer method developed in New Zealand (Jebson, 1963, 1965). The blended batches of casein are then bagged off for palletized storage.

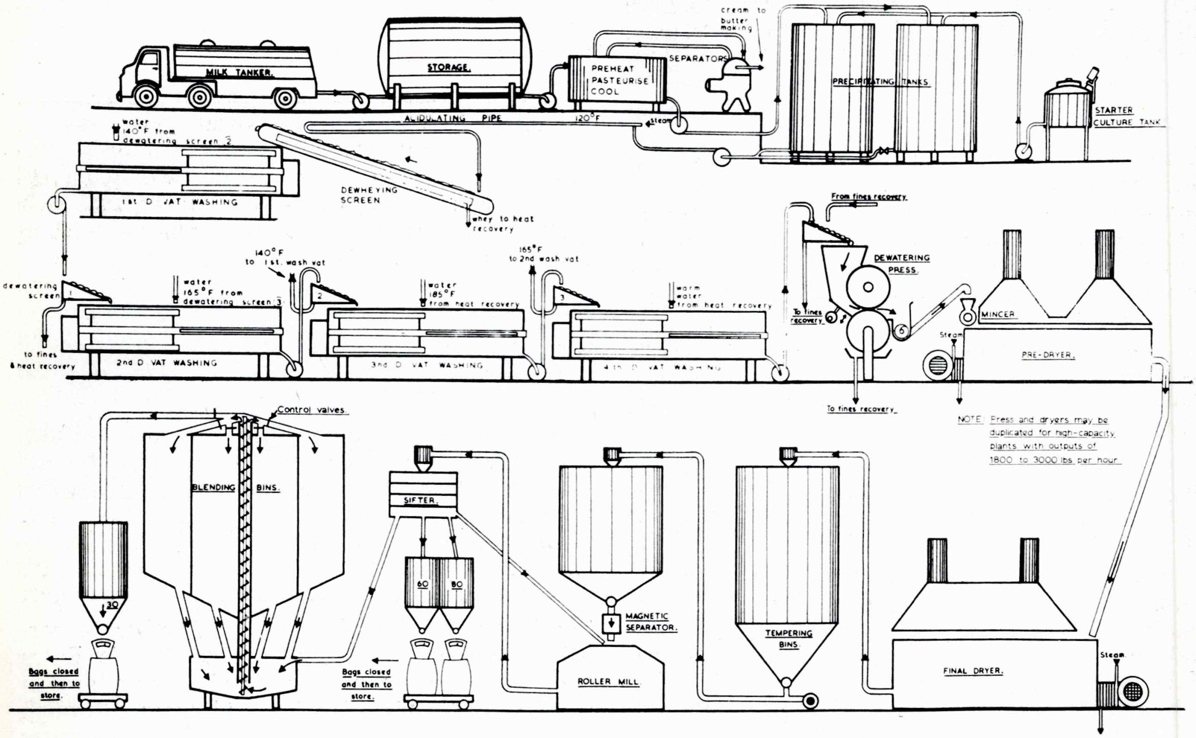
Rennet Casein Manufacture

Little specific development has taken place in rennet casein manufacture. The skim milk is generally clotted in cheese vats and cooked therein before being passed to washing and drying systems essentially as described above. The particle size is, however, controlled during the coagulation and cooking stage and the product is merely sieved to remove oversize particles before packing.

Some variants in methods of manufacture of rennet casein, including processes for continuous coagulation and changed agitation procedures during clotting, have been tried, but are not now used because, although analytically the quality of the casein so produced is better, some difficulties were experienced in usage due to the presence of occluded air in the particles.

Other Caseins

Whereas in some other countries, notably Australia, it was possible to utilize hydrochloric acid for the manufacture of casein, this has not been possible in New Zealand because of the cost of the acid. Investigations have, however, shown that sulphuric acid, which is available cheaply, can be used and a satisfactory product produced (King, McDowall and Richards, 1962).


MILK TANKER.
STORAGE.
PREHEAT
PASTEURISE
COOL
SEPARATORS
cream to butter making
PRECIPITATING TANKS.
STARTER CULTURE TANK
ACIDULATING PIPE
120°F
steam
water 140°F from dewatering screen 2
1st D VAT WASHING
DEWHEYING SCREEN
whey to heat recovery
From fines recovery.
DEWATERING PRESS.
140°F to 1st. wash vat
165°F to 2nd wash vat
dewatering screen
1
water 165°F from dewatering screen 3
2
water 185°F from heat recovery
3
warm water from heat recovery
To fines recovery.
6
MINCER
Steam
PRE-DRYER.
to fines & heat recovery
2nd D VAT WASHING
3nd D VAT WASHING
4th D VAT WASHING
To fines recovery.
NOTE: Press and dryers may be duplicated for high-capacity plants with outputs of 1800 to 3000 lbs per hour
Control valves.
BLENDING BINS.
30
Bags closed and then to store.
SIFTER.
60
80
Bags closed and then to store.
MAGNETIC SEPARATOR.
ROLLER MILL.
TEMPERING BINS.
FINAL DRYER.
Steam

Flow sheet for manufacture of acid casein by continuous D-vat process.

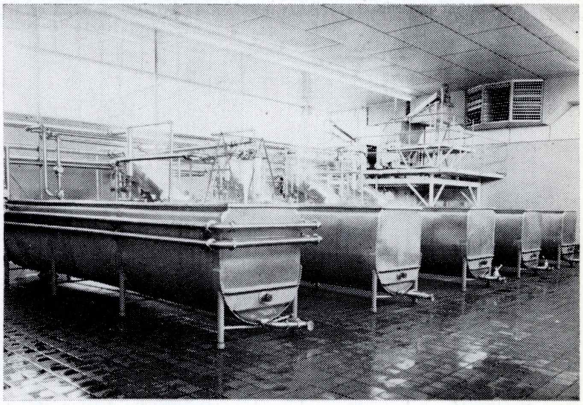
skim milk to about 88-90°F, adding rennet to cause coagulation in about 30 min, heating the coagulum in a jacketed vat, with careful control of rate of heating and agitation, to reach about 135°F after about 1h. Following this the curd and whey are separated and the curd washed, pressed, dried, and packed as for lactic casein.

Lactic Casein Manufacture

The skim milk is usually inoculated with starter in large vertical silo tanks of from 4,000 to 25,000 gal capacity. The coagulating process takes some 16 h and after this time the pH is usually in the vicinity of 4.5. The curd is then pumped via a direct steam injector where it is heated to around 125°F and passed through a holding pipe and/or vat which allows the curd to agglomerate and shrink ('acidulate'). The curd/whey mixture then passes to a series of separation and washing stages. There are a number of variants but the two main processes utilize either what is known as the D-vat system or the McKenzie & Ridley equipment.

In the former the curd is separated from the whey on a fine mesh, sloping, stationary screen and from which the whey is discharged to fines and/or heat recovery and thence to other uses, or waste. The curd passes forward through a D-vat, so-called because of its shape, where it is agitated in washing water, usually at about 135°F. The curd and water are pumped continuously from the opposite end of the D-vat over another stationary screen from which the curd passes to a second wash at about 155°F. The curd is similarly treated with a third wash at about 175°F, and a fourth wash at about 90°F, before being discharged over a final stationary screen to a roller-type press. Where only three washes are used, the second wash is usually omitted, the hot wash being necessary to control curd characteristics for drying and for hygienic reasons. The temperature of the fourth wash is critical as it controls the manner in which the press operates. The wash water is usually added fresh at the third or fourth wash and flows back in counter-current to the curd so that all of the wash water is discharged from the screen above the second wash vat to fines and/or heat recovery. A considerable number of variants exist in this washing system, some companies utilizing two fresh water streams and different temperatures. These local variations have little effect on the product although they may affect the ease with which it may be handled in the particular plant.

The McKenzie & Ridley equipment consists of a travelling fine mesh belt on which the cooked acidulated curd is held while the whey passes through. This curd may be subjected to a spray of fresh water and sometimes a rudimentary pressing as it passes up the belt whence it discharges into the first stage of the washing machine proper. In this machine the curd and wash water are agitated together with a reciprocating agitator and the curd is finally removed by a chain of perforated stainless steel mesh buckets which carry the curd out of the wash water and deposit it into the next washing stage. Wash water is removed from the machines via rotating fine mesh screens, which reduce fines loss and are kept clear of blockage by their rotary movement. After several such washing stages the curd passes to a belt press in which the curd is discharged onto a belt which carries it through several sets of squeezing rollers. It is then discharged for drying. The wash water may be arranged to flow counter-current to the curd, or several fresh streams may be used. Temperatures are generally similar to those in the D-vat process. This washing method has a restricted throughput equivalent to about 5,000 gph of skim milk, while the D-vat method is generally satisfactory at up to about 10,000 gph. Hybrids of these two systems exist; quite frequently the initial curd separation belt is utilized with the D-vat process and the D-vat process press is utilized with the McKenzie & Ridley machine.


Typical D-vat installation in a casein factory. Note filtered air inlet.

The pressed curd passes on to the driers. The familiar Pillet drier has now generally been superseded by the locally designed and made Bates drier although some new developments are in train. In the Bates drier the casein passes through a mincer onto a vibrating perforated conveyor through which warm air is blown. After travelling about 20 ft along this conveyor it passes through a valve on to a lower tray on which it is conveyed back to below the starting point. Hot air is

CASEIN

By D. W. KING
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Prior to the 1950s casein was generally regarded in New Zealand as a product to be manufactured by cheese factories at times when the price of cheese was low in relation to the price of casein and butter. Some specialized casein factories were in existence and these provided the drying, grinding, and packing facilities for the washed, pressed curd produced either within the company or by surrounding cheese factories.

The quantity of casein under this system usually ranged between about 1,000 and 5,000 tons of casein per year, and because of the intermittent nature of casein production little had been done to improve the process or equipment, although some of the specialized factories produced a high quality product.

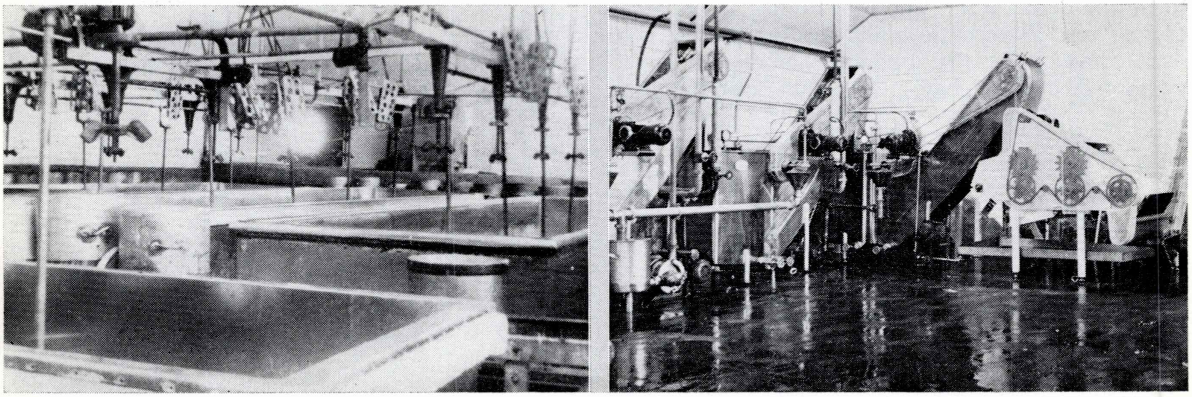
During the 1950s the introduction of tanker collection increased pressure on dairy factories to manufacture products from skim milk. At the same time, changes in the American price support programmes improved the marketing prospects for casein. These two factors combined to cause a rapid rise in casein production to around 25,000 tons in 1960 and between 60,000 and 70,000 tons per annum in the last few years. New Zealand is therefore now by far the largest producer and exporter of casein in the world, a position it has held for about ten years.

Needless to say this rapid increase in production has been associated with a revolution in manufacturing methods and a considerable increase in scale of individual processing units. Thus, whereas a factory producing casein from more than 20,000 gal of milk per day was large prior to the 1950s, today the smallest units are larger than this and the large ones can process more than 100,000 gal per day.

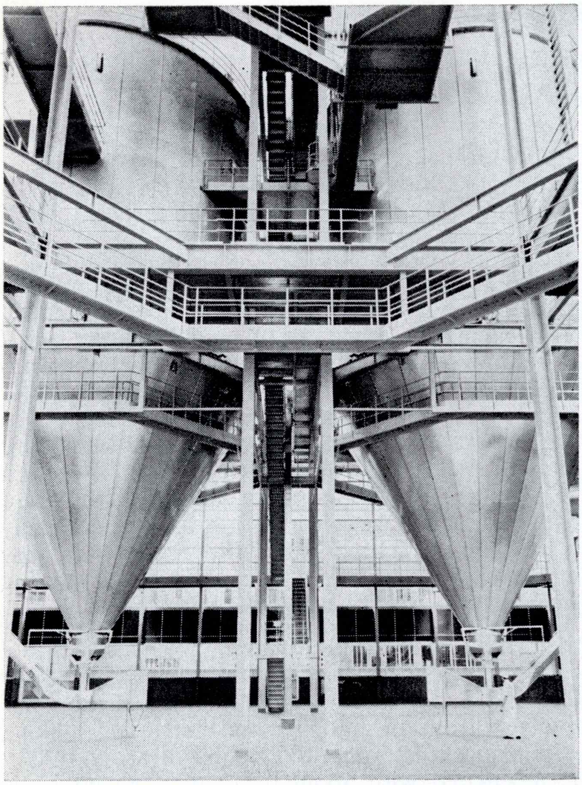
The technical development work permitting this rapid increase was done in a number of places, with significant advances in manufacturing efficiency and product quality being made by several individual dairy companies, the New Zealand Dairy Research Institute, the Dairy Division of the Department of Agriculture, and the machinery manufacturing companies (King, 1962; King and Jebson, 1970). Because of the co-operative nature of the industry, advances made by one company were rapidly shared, with the result that very efficient, large-scale methods of manufacturing high quality caseins were quickly evolved.

Two major varieties of casein are manufactured in New Zealand — lactic and rennet. The New Zealand lactic casein manufacturing method has evolved from traditional procedures for making casein in cheese vats. Skim milk at around 78°F is inoculated with about 0.5% of a mixed lactic starter and allowed to stand for about 16 h, by which time coagulation has taken place. The temperature of the coagulum is then raised by direct steam injection when the curd forms into granules with expulsion of the whey. The curd and whey are then separated and the curd subjected to three, and sometimes four, washes at various temperatures, after which it is pressed, washed, dried, ground, blended, and packed.

Rennet casein is manufactured by warming



Then and now — older-type casein processing equipment (left) in the Oroua Downs Dairy Company's factory before it was replaced with modern McKenzie and Ridley equipment (right).



Two of the three drying flumes, each with a capacity of 5,500 lb powder per hour, installed at the Te Rapa Branch of the New Zealand Co-op. Dairy Co. (*National Publicity Studios, Wellington*).

quantity of whole milk powder for export, are packed or gas-packed in tins ranging from 1 to 100 lb.

The methods adopted for filling the multiwall bags have been the result of a considerable amount of experience gained through a number of experiments conducted in New Zealand by both equipment manufacturers and the dairy companies themselves. Automatic filling machines have now been developed, the operator having only to position the lined bag under the powder filling head and then to transfer the filled bag to a vibrating conveying belt where it is consolidated and sealed by a taping and stitching machine.

After packing, the milk powder is stacked onto pallets and transported to a bulk store. Unlike butter and cheese, which are held in large cool stores at ports around New Zealand, the milk powder stores are normally adjacent to the individual milk powder factories.

The future of the milk powder industry throughout the world must be regarded as being extremely bright. The growing recognition by the East Asian countries of the value of milk and milk powder as a food has established a market of great potential and with the increasing demand for formulated, convenience foods, milk powders are finding an increasing outlet either in their own right or as a dried product in combination with a number of other ingredients.

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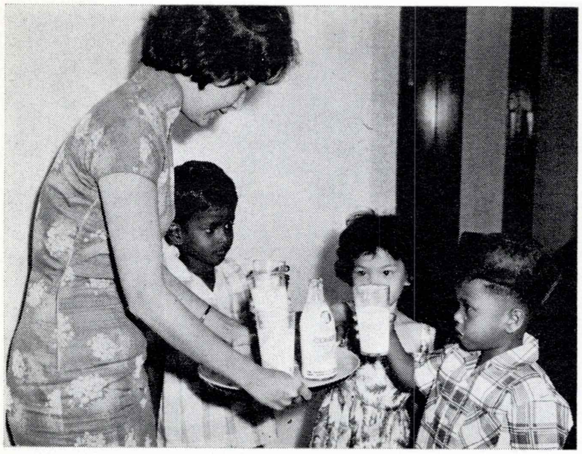


"Fernleaf" brand New Zealand milk, recombined in Singapore from milk solids, is popular in the island city. Here children of Chinese, Indian, and Malay origin sample the product.

forms 90% of the milk we produce, are vitally interested in any possibility for equalizing competition on overseas markets through reduction in export subsidies, and in gaining freer access to countries where the demand for high-quality dairy products could be built up.

As an organization representing the New Zealand dairy industry we work closely with the New Zealand Government in making use of every opportunity to promote these views internationally, and to use every opening offered by diplomacy to extend the frontiers of our trade, or to make it more profitable. It was on New Zealand's initiative that the GATT last year took up the proposal for a reduction in export subsidies for skim milk powder which from the beginning of 1970 led directly to a substantial improvement in the returns for skim milk powder for all exporting countries. During the negotiations that resulted in the conclusion of this international agreement, New Zealand asked that it should be considered the forerunner of agreement on other products, and in recent months meetings within the GATT have been held in an effort to work out an agreement, similar in principle, which would apply to butter and milkfat. Success would bring great benefits to us and to all other dairy product exporters.

It is clear that the view from the marketplace today is one of challenge — a challenge to continue to improve our existing products, and to develop a wider range of new products which will be manufactured to the specifications of buyers in the prepared foods, pharmaceutical and other industries, a challenge to use to the maximum all the physical resources, and all of the many and varied scientific, technological, and practical skills of the industry. We are confident that this challenge will be met.

ARRANGING THE SUPPLY OF PRODUCTS

By J. G. REVELL
New Zealand Dairy Board, Wellington, New Zealand

A basic essential for those in the business of marketing is machinery to ensure that goods wanted for the market are available not only at the time required but also in accordance with any nominated specification and packed in a manner to suit the particular needs of the buyer. At the same time this machinery should be geared to translate into reality ideas for increased market opportunities either by way of modification to existing products or in the development of new ones. In the New Zealand dairy industry this machinery is provided through the New Zealand Dairy Board and these specific activities form an important function of the Board's Supply Division.

Pattern of Manufacture

With New Zealand's present population of 2.4 million cows, and assuming normal climatic conditions, there will be available for manufacture into dairy products in the 1970/71 season something over 600 million pounds of milkfat, almost all of which will be delivered to dairy factories in the form of whole milk by milk tankers. There are 98 dairy companies in New Zealand, cooperatively owned and controlled by the dairy farmers, and between them these companies operate 160 manufacturing units. Even before the current season started on 1 June last, the Board had obtained from each of these companies an indication of their manufacturing plans for the 1970/71 season and already market requirements have been matched against these plans. In the meantime circumstances have changed — some companies have lost suppliers so that their expected levels of manufacture have altered, and new market pressures have become apparent. While the latter have little effect on

The mobility of milk permits considerable flexibility in its end use. Between 85-90% of milkfat processed by dairy factories in 1970/71 will be delivered by milk tanker.

the 77 single process companies (47 make cheese only, 16 butter only, 11 butter plus only casein and 5 butter plus only skim powders) they do influence the decisions of those companies which have the facility to switch their milk supply between alternative manufacturing processes. These companies, dominated by the mammoth New Zealand Co-op. Dairy Company, control about 65% of the total milk supply to be processed this season.

Thus, while the pattern of manufacture for 1970/71 is already determined to a certain extent by the limitations of some of the companies, there is this substantial volume of milk which can be shunted between processes to take advantage of market returns or to meet the needs of particular circumstances. These decisions on the pattern of manufacture to be followed ultimately rest with the companies themselves and they are made in the light of a number of factors, including comparative returns, the company's own circumstances, and the Board's indicated requirements.

To assist the companies in making their decisions the Board, either directly or through its Product Committees, will ensure that they are kept fully informed not only on the level of returns being achieved but on the short and long-term market requirements. Most of the companies in a position to choose between manufacturing processes are sufficiently responsible to balance the short-term advantage against the long-term benefits and will accept that it is sometimes necessary to manufacture the product which may not be yielding the greatest return in order to protect established business with continuing outlets.

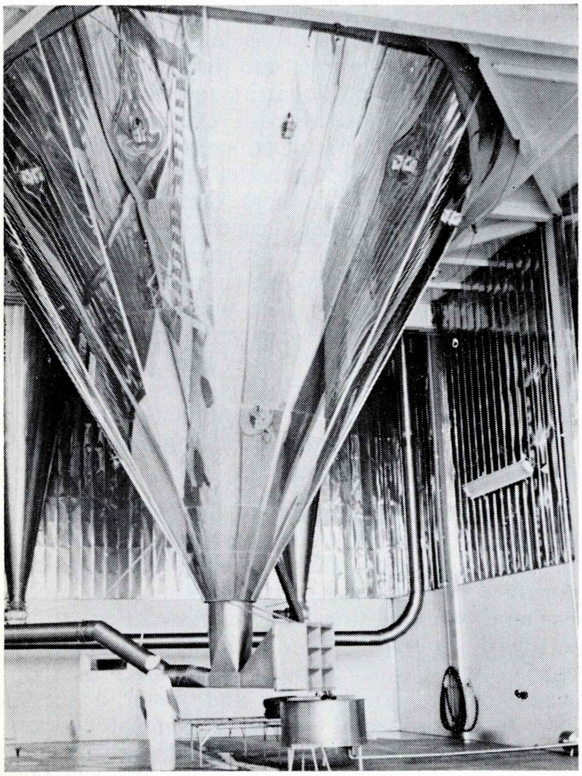
Diversions

However, it may well be that a situation will arise where the difference in returns between alternative products is too great for a company to be able to justify to its suppliers the need to retain milk in a lower paying product, or the Board itself may decide that there should be a deliberate adjustment of the manufacturing pattern by the switching of milk from one process to another. Over recent years there has been the need for a number of such diversions and these have been arranged by the Board to secure additional supplies of both cheese and specification milk powders. Sometimes diversions have run for an entire season or for only part of a season; sometimes the diversion may be restricted to ensure milk supply for a specific company manufacturing a particular product. While these diversions can be arranged quite readily within a company, it is usually found that the adjustment required involves the transfer of milk from the ownership of one company into the hands of another. This occurs particularly in the case of transfers into and out of cheese, for the reason that most cheese manufacture is undertaken by single process companies.

In operating these arrangements the Board offers to diverting companies terms which are aimed to be sufficient to encourage them to release milk for delivery to other manufacturing processes. Allowances are also paid to cover the cost of milk transport and in the diversions which have been organized over the past few seasons large volumes of milk have been moved between companies, sometimes over considerable distances. The extensive use of the milk tanker and the resulting mobility of the raw material permits considerable flexibility in its end use. Although there is an element of inconvenience both to the diverting and receiving companies in these milk diversion arrangements, the success achieved in diversions to date reflects the high level of collaboration which has been obtained between the companies concerned and the Board.

Non-Standard Products

While the Board plays a major role in ensuring that milk flows into a desired general balance as between the various manufacturing processes, there are specific and increasing complications associated with each variety of dairy product. Whereas not so many years ago New Zealand was selling all its dairy produce, then mainly butter and Cheddar cheese in a basic form, to a single market, it now sells an extensive variety of products in an increasing number of markets with many of these virtually tailored to customer requirements.



Frequently a buyer's requirements can be met from only one particular plant, or manufacture to his specification is possible at only certain times of the year. Photogfaph shows a typical spray drying flume (Manawatu Co-op. Dairy Co., Palmerston North) used for the manufacture of specification dairy products. (*C. Rofe, N.Z. Dairy Research Institute*).

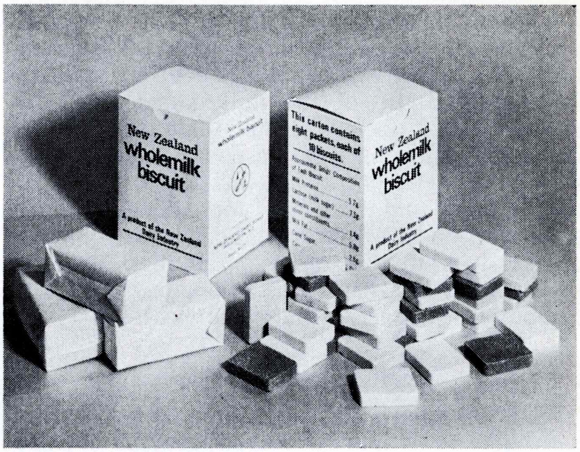
The greater proportion of milkfat processed by dairy companies continues to be manufactured into butter, and provided the product is manufactured to the Board's specification, packed in an approved export container, delivered to an approved store, and certified suitable for export by the Dairy Division of the Department of Agriculture, it will be purchased by the Board. Broadly speaking, these same general principles apply to each of the standard dairy products. A purchase order and a specification is issued each year and companies are free to manufacture against this order.

The extension of the business of the Board into new products as a result of a general expansion of the industry, the rapid movement into the processing of whole milk, and the active and continuing search for new outlets for dairy products, has meant an enormous increase in what are termed 'non-standard' products. These are the products which depart in any way from the normal specification; they are the special varieties or packs which have been developed for particular markets. Their numbers are many and the varieties are far ranging. There is a heavy responsibility on the Board's officers in ensuring that provision is made for the manufacture of these products as required, and the tailoring of manufacturing programmes to this end calls for much careful planning.

The statements which the Board receives from dairy companies covering their manufacturing plans form the general background to this planning and already this season, in anticipation of the needs of regular customers, the various product officers have endeavoured to allocate this manufacture. Alterations will be necessary, however, as further requirements become known or the plans of manufacturers are altered. It frequently happens that the buyer's requirements can be met from only one particular plant or that manufacture to his specification is possible only at certain times of the year. In these circumstances it is necessary for the product officer to negotiate with the company or companies concerned to ensure that the specific requirements are met. In addition to product specification these negotiations often cover special forms of packing or delivery arrangements involving variations in the normal terms of purchase.

Product Development

Dovetailed into the day-to-day planning for the future availability of goods for the marketplace is the organization and control of experimental work, essential to product improvement, better presentation, or the development of new products. While ideas are coming forward continuously from research and development personnel within the industry, information on opportunities is also received from the Board's agents scattered throughout the world or from information feeding back as the result of overseas visits by Board staff. It is necessary that this information be co-ordinated and assessed before determining a path of action to be followed. Some projects can be relatively straightforward and capable of rapid implementation, but for oqthers the exercise is more exacting. The resources of the industry, particularly in terms of technical personnel, are limited so that it is necessary at all times to carefully assess relative priorities.


New Zealand wholemilk biscuit
A product of the New Zealand Dairy Industry
This carton contains eight packets, each of 10 biscuits.
New Zealand wholemilk biscuit

In arranging the supply of products there is an essential need for machinery to translate into reality ideas for increased product opportunities in the development of new products or product variants. The New Zealand Wholemilk Biscuit is an example of a completely new product. (*Bruce Watt Studios, Palmerston North*).

New product development normally requires close liaison between the Board's officers, the Dairy Research Institute, and the Dairy Division and it is usual to pool as much information as possible before a decision is taken on a course of action. Often some preliminary experimental work may be necessary and in these cases we call upon the resources of the Dairy Research Institute or the dairy companies themselves. The larger and more versatile dairy companies now emerging have found a need for their own technical research and laboratory facilities so that they too are being called upon to participate in product development, although in the normal course of events work which they are asked to carry out would be related to processing they are already undertaking. Some of these new developments require the expenditure of substantial sums of money, either at the research stage or in arranging manufacture by a company, and it is necessary to submit a proposition for approval to the Board itself. This having been obtained, the Board's officers negotiate special arrangements with a dairy company carefully selected as suitable for the particular project.

Criteria used in the selection of a suitable factory could include location, the extent to which it may already be committed to other non-standard products, type and capacity of plant available, suitability of raw materials, storage facilities both at the factory and at the appropriate cool store, general appearance and management.

The special arrangements could include provision for the underwriting of additional equipment required, and would certainly cover a detailed purchase formula for the product in question with special forms of guarantee for an initial experimental period. The Board also endeavours to include in its offer a measure of incentive for the company as an encouragement to its effort and to compensate for the indefinable items of cost and additional inconvenience which are inevitably associated with exercises of this nature. The objective is of course the production of an acceptable end product at the earliest possible date, and it is here that the product officers exercise further responsibility in co-ordinating the efforts of all parties including the various outside firms which service the industry. At times, even with the best will in the world, results are slow and one can only share a sense of frustration, but there have been, and there continue to be, many occasions when the effort is highly successful to the benefit of the industry as a whole and the enormous satisfaction of the parties immediately concerned.

Although the organization of the New Zealand dairy industry seems to be a target for frequent criticism, through the efforts of the separate dairy companies both in healthy competition with each other and working together in association with the Board, through the co-ordination of manufacturing plans, and through the efforts of the Board's officers to organize and foster a joint effort in experimental and development work, the industry is well placed both to take advantage of market opportunities for traditional products, products manufactured to customer specifications, or completely new varieties, and to maintain the desired balance of manufacture to service an increasing share of the world's export trade in dairy produce.

GETTING THE PRODUCT TO THE MARKETPLACE

By G. H. DALZELL

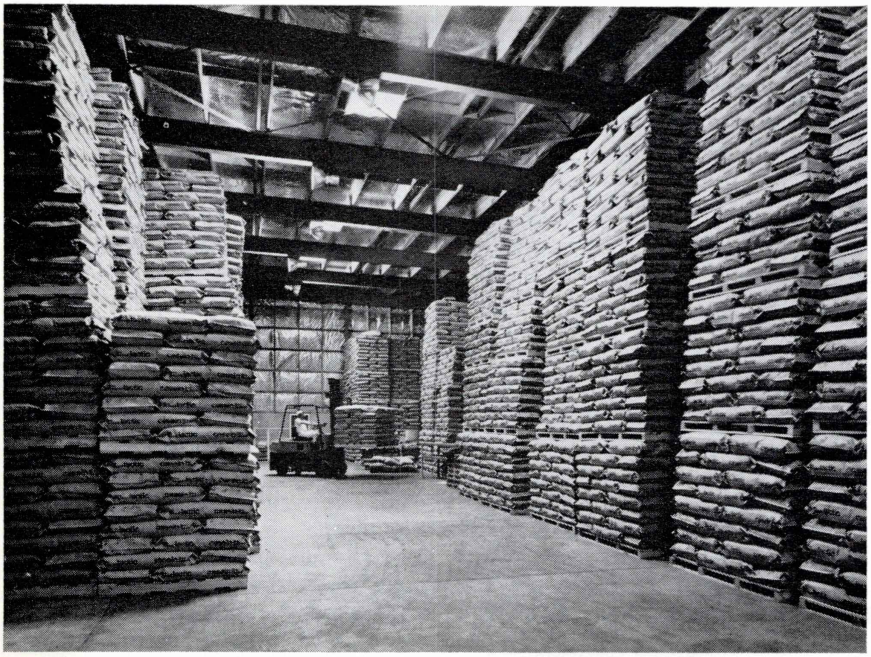
New Zealand Dairy Board, Wellington, New Zealand

New Zealand's position as the world's largest exporter of dairy products could be said to have been initiated by the shipment of a few packages of butter in the sailing shop "Dunedin", when the first cargo of refrigerated produce was shipped from New Zealand on 2 February, 1882. Technological advances in refrigeration techniques had given the infant industry just the opening it needed to convert the climatic production advantages enjoyed by New Zealand into a marketing advantage almost anywhere in the world. For many years, and through two world wars, we saw the rapid development of the industry into its position as the major supplier of butter and cheese to the 'home country' — the United Kingdom — where for many many years our almost total allegiance in terms of reciprocal trade lay.

In the 1930s and '40s, further advances in technology enabled the development of trade in dried milk solids, in the forms of casein and milk powder, to progress, and since the second world war this field has shown remarkable progress. A post-war world in urgent need of protein created the necessary buyer demand and the development and sophistication of products has continued to progress up to the present day.

On the shipping scene, the first 50 to 60 years saw the development of an increasingly sophisticated fleet of refrigerated ships by a small group of British shipowners, who provided a very efficient 'pipeline' service direct between New Zealand and the United Kingdom ports. This narrow-based service gave the necessary trade link for many years. However, after the second world war, we quite suddenly found a need for much wider-based services to open up newly available markets for the growing range of products which were being produced in excess of requirements for the traditional United Kingdom market.

The pressure from dairy and other primary product exporters created a rapid expansion in shipping services to many new parts of the world and in this field we are indebted to many foreign-based shipping companies who had the initiative and foresight to anticipate the long-term prospects of the new trades. Today the dairy industry makes use of over 25 shipping services, serving over 70 countries around the world. The industry now ships from 12 New Zealand ports to approximately 90 overseas ports. Shipments now total about 550,000 tons per annum, about half of which go to the traditional United Kingdom market. This market still takes the bulk of the



Casein in a typical dairy company store awaiting shipment to overseas markets. (*Lindberg Photo Productions, Hamilton*).

The Dairy Board's computer plays an essential part in recording, analysing, and predicting receipts of export products into store, and sales and shipments of all dairy products to the 100 markets in which the Dairy Board is selling. (*Photo News 1969 Ltd, Wellington*).

butter and cheese, and the newer markets take the great proportion of the non-fat products.

The development of a diverse world market has called for very much more sophisticated shipping techniques as compared with the very simple "pipeline" trade with the United Kingdom. The Dairy Board's Shipping Department is required to liaise closely with the Marketing and Supply Divisions of the Board, to ensure that adequate services are in fact, available, or can be made available, to enable the markets to be developed and held. This work requires close co-operation with the shipping companies, both in the long-range planning and development of services as well as in the very great volume of day-to-day bookings of a diverse range of products for shipment from and to many ports.

The layman perhaps does not at first appreciate the complicated nature of the transport, both internally and by sea, of a wide range of largely fragile cargoes that makes up the bulk of New Zealand's exports. The ships are largely very sophisticated 'warehouses', required to carry a wide range of both refrigerated and general cargoes, many of which require separate stowage to give the right carriage conditions. For dairy products alone, a ship can be required to carry butter, cheese, ice cream, frozen cream, milk powder and/or casein — each in separate spaces, at the necessary carriage temperatures and conditions. The same ship can also be carrying other products, such as fruit, crayfish, and several types of cargo, which again require their own separate stowage for a variety of reasons.

In addition to the basic provision of services and cargo bookings, the Board has developed a highly specialized Documentation Centre, to cover the great volume and often complicated documents required to support every sale and shipment made.

The Board has also developed a highly respected shipping inspection service, whereby qualified refrigeration engineers assist and guide the internal and external transport services to provide suitable carriage conditions for the produce. This inspection service, both in New Zealand and in the United Kingdom, does much to maintain and improve the high standards of handling and hygiene required for dairy produce by both the producers and the buyers.

The future of New Zealand's shipping holds several exciting challenges in the continuing development of competitive services to the ever-spreading markets. In keeping with the worldwide transport revolution developing in the 1970s, we will soon see the introduction of the cellular container ships to North America and to the United Kingdom. Along with these radical changes in transport modes, we can expect further developments of the unit load concept with special hatch-loading, sideport loading and roll-on/roll-off ships.

The dairy industry is well placed to meet this changing transport scene. The unified co-operative industry control and single marketing and shipping system promises to be a powerful base to enable the most effective and efficient use to be made of the new transport methods. The industry has already rationalized its export packs to a high degree and in association with the dairy companies and other interests is currently examining its packaging with the view to introducing new dimensions more suitable for containers and unit loads.

Container shipping is to be introduced during 1971 by three shipping lines operating from New Zealand to North American East Coast ports, to which shipments are currently about 40,000 tons a year. In late 1973, four container ships are to be progressively brought into service by the British lines operating to the United Kingdom and these will be capable of carrying over 400,000 tons of export cargo annually, of which approximately 140,000 tons could be butter and cheese, and 20,000 tons casein and milk powders. After 1973, therefore, we could have approximately 200,000 tons of dairy products a year being carried to export markets in containers, and around 350,000 tons still in more conventional-type ships. The Board thus has to plan its packaging and the transport arrangements, internally and externally, for both container and conventional services.

After the introduction of the presently programmed container shipping, it will still be essential for the Board to have the benefit of sophisticated services to over 90 markets throughout the world, mainly in the more conventional-type services for at least some time.

The dairy industry has achieved a high degree of 'freighting efficiency' to date and is confident that this efficiency can be further improved for the new transport modes, and it hardly needs stating that the Board expects this efficiency to be reflected in the freight rate structure of the container era.

DAIRY MANUFACTURING RESEARCH IN NEW ZEALAND

By W. A. McGILLIVRAY

New Zealand Dairy Research Institute, Palmerston North, New Zealand

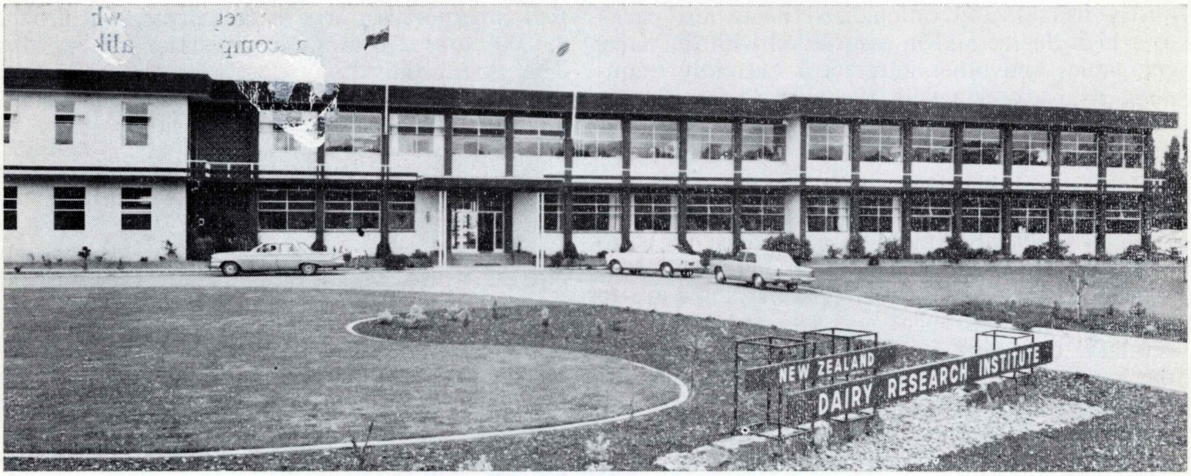
As has been mentioned in an earlier article (Stichbury, 1970) effective research backing for the New Zealand dairy industry at the farm production level is provided by various research organizations, supported by Government through the Departments of Agriculture or of Scientific and Industrial Research. The dissemination of research findings is also well organized through advisory services provided by the Dairy Board, the Department of Agriculture, individual dairy companies, and groups of farmers. On the manufacturing side most research and development work for the dairy industry, relative to both traditional and new products and to methods of processing, is undertaken by the New Zealand Dairy Research Institute, although increasingly scientific backing is being provided by some of the larger dairy companies and by the Technical Division of the Dairy Board.

The Dairy Research Institute is an independent research organization, financed by Government through the Department of Scientific and Industrial Research and by the dairy industry through the Dairy Board (McGillivray, 1966). It is situated at Palmerston North adjacent to the Applied Biochemistry, Grasslands, and Plant Physiology Divisions of the Department of Scientific and Industrial Research, and opposite the Massey University campus.

The Institute was established in 1927 and from its inception quickly demonstrated to a somewhat sceptical industry the value of sound scientific backing. During its early formative years it set the pattern, not only for its own development, but also for that of the many other research associations which have since been set up in this country to service all of the major industries and many of the smaller ones — a pattern whose essential feature is close association of the scientist with the practical man in the field.

On this basis the Institute has over the years become accepted as an essential part of the New Zealand dairy industry, and the stage was reached when the main limitation on the activities of the Institute was lack of space for laboratory work, engineering and workshop facilities, and for factory processing. These problems were overcome in 1966 with the provision of a specially designed modern laboratory block, and in 1968 with the erection of an associated Processing Hall equipped for the pilot-scale manufacture of all types of dairy products (Anon., 1966).

In keeping with the progressive outlook of the industry towards diversification into new types of dairy processing and new uses for dairy products, as well as improved methods of manufacturing traditional products, the Institute has expanded rapidly over recent years. Some years



A general view of the New Zealand Dairy Research Institute's laboratory block. (*C. Rofe, N.Z. Dairy Research Institute*).

before the new laboratory building was completed a vigorous staff recruitment and training programme was undertaken, a number of suitable young graduates receiving specialist training at various overseas laboratories, and returning to the Institute when the new space became available. The staff of the Institute is now 130, made up of biochemists, chemists, engineers, and microbiologists, together with technicians and other supporting staff including dairy plant operators.

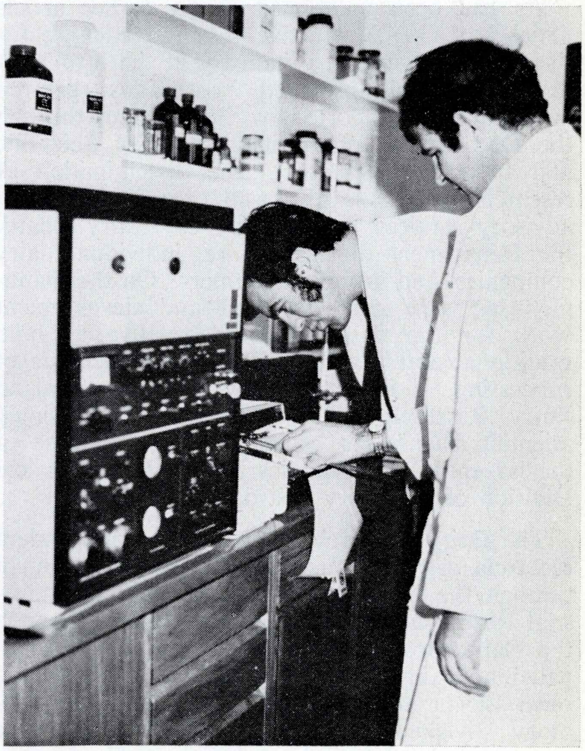
Work of the Institute

Unlike most other dairy research institutes, the New Zealand Dairy Research Institute is not concerned with production of milk on the farm. In broad terms its research activities cover all aspects of manufacture, from the time the milk is collected from the farm until the product is used by the customer, and the types of investigation undertaken are correspondingly diverse. Currently, about half of the effort of the Institute is directed to the solving of immediate industry problems; the other half is of a more fundamental nature, intended to provide background information for the applied projects.

Until about five years ago almost all research was devoted to problems associated with traditional dairy products. Work of this type has continued on a steadily increasing scale, but the major expansion at the Institute has been in the field of product development and process modification to meet changing market requirements, to the stage where just over half the effort, both applied and fundamental, is now in this latter area.

New Products

This new product work covers the whole range of dairy manufacture and includes a variety of milk protein products, modified milk powders of various kinds, new cheese types, various whey products, and special butters and related products



Flavour chemistry studies. (*C. Rofe, N.Z. Dairy Research Institute*).

in which milkfat predominates. This work is undertaken in close association with the Dairy Board and because of the commercial implications cannot be discussed in detail. In general terms, however, the emphasis is on the "tailormaking" of products to meet the increasingly exacting requirements of customers or potential coustomers, particularly food formulators who are interested in expanding the range of uses for dairy products. These customers are encouraged to work with the New Zealand dairy industry through the Institute, firstly in defining the characteristics they require in the milk products, then in developing the necessary chemical, physical, and microbiological tests to cover these specifications, and finally in continually improving the products or extending their use pattern. This work involves close association not only with all sections of the New Zealand dairy industry but also with agents and customers, and staff of the Institute frequently accompany Dairy Board missions to the marketplace to discuss technical matters at first hand and to further their knowledge of market requirements. This complete integration of scientific and technical resources with manufacturing and marketing is one of the factors which contributes significantly to the success of the New Zealand dairy industry and to the regard in which it is held by customers and competitors alike.

Investigations into the characteristics of bacteriophage. (*C. Rofe, N.Z. Dairy Research Institute*).

Traditional Products

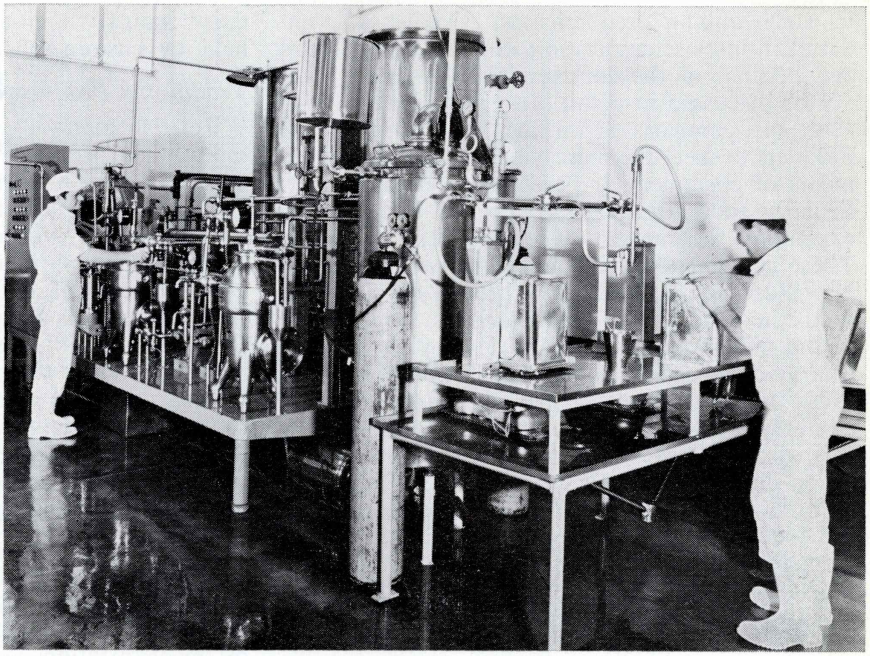
Relative to traditional dairy products, many of the applied problems currently being investigated are those which have occupied the attention of staff of the Institute since it was first established. These include various aspects of cheese and cheesemaking, particularly the handling of starters and the control of bacteriophage; rheology of butter; chemical and physical properties of milkfat; and factors affecting the flavours of dairy products. Over the years considerable progress has been made in most of these fields, but changes in dairy manufacturing techniques associated with larger and more diversified factories, and changing market requirements, continually raise new problems and highlight areas requiring further investigation.

Thus the recognition of the importance of cheese starters in flavour development, as well as in acid formation, together with the advent of mechanization with the associated repeated filling of vats, has necessitated a considerable amount of rethinking and the introduction of new starters and systems of handling starters. These have fortunately been facilitated by the increasing availability of laboratory services to dairy factories, a development to which the Institute has also contributed significantly.

Despite expansion in the quantity and range of non-fat products manufactured, three-quarters of dairy-farmers' incomes still derive from predominantly fat products. Consequently, considerable emphasis is placed on buttermaking and on the general properties of milkfat and butter. This has intensified as a consequence of the rapid transition to continuous buttermaking in New Zealand and the new types of problem introduced by this change. In many instances, too, the advent of new techniques has facilitated much more meaningful investigation of aspects of dairy science and technology which were beyond the scope of older methods. This applies particularly in the flavour field where the increasing use for edible purposes of products such as milk proteins, and the more exacting requirements of food formulators generally, is focusing attention on flavours, both desirable and undesirable, in dairy products.

Institute Developments

Many problems, both in relation to new and traditional products, are brought to the Institute by the industry, either through the Dairy Board or directly by individual manufacturing units.

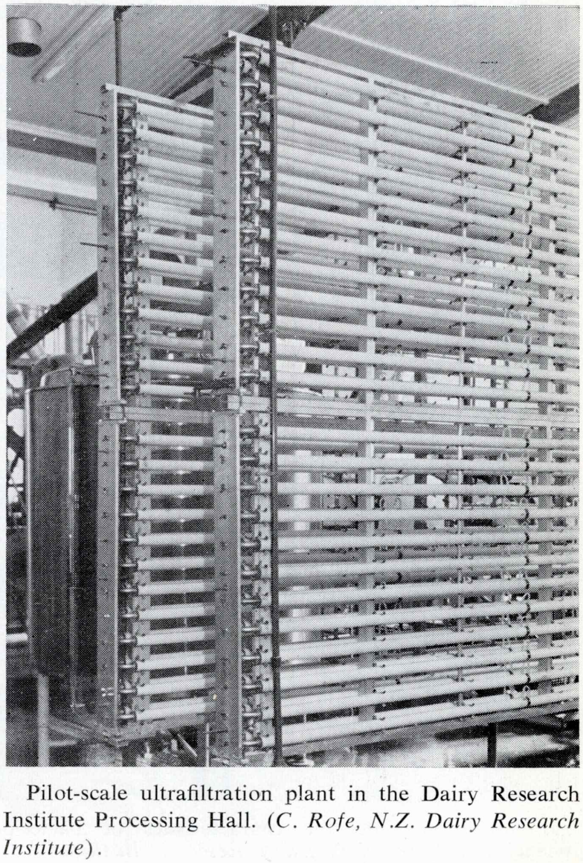


Work on the fractionation of milkfat in the Institute Processing Hall. (*C. Rofe, N.Z. Dairy Research Institute*).

However, any research organization which relies entirely on external stimuli of this type would quickly become sterile and the Institute, because of its close association with the industry, is continually able of its own volition to initiate useful lines of applied investigation. One of the recent major research efforts of this type has been the development of equipment for mechanizing the cheesemaking process. Commenced less than a decade ago this work has already led to the development of the *Cheddarmaster* process, which is now the most widely used mechanical system in the world, the Large Hoop system of pressing, the *Vatmaster* mechanized vats, the perfection of a number of associated items of equipment, and the bringing of *Pressmaster* to the stage of final commercial testing.

Fundamental Research

On the more fundamental side, the emphasis has been on the establishment of a few specialized groups, rather than attempting an excessively broad, and consequently shallow, coverage of the whole field. Thus one group is investigating various aspects of the metabolism of lactic streptococci; another is studying the finer structure of milk proteins; and smaller groups are working on flavour chemistry and on the structure of milk triglycerides. All of this work is closely integrated with the long-term requirements of the applied groups for more basic information about the products and methods of manufacture with which they are associated.



Pilot-scale ultrafiltration plant in the Dairy Research Institute Processing Hall. (*C. Rofe, N.Z. Dairy Research Institute*).

General

Considerable importance is attached at the Institute to the rapid dissemination of the results of scientific investigation. Much of the work is published in the scientific literature of the world; the New Zealand Journal of Dairy Science and Technology, the official organ of the New Zealand Society of Dairy Science and Technology, is published predominantly from the Institute; information of more local relevance is made available through a quarterly "News Circular"; and the Institute organizes numerous industry seminars and conferences, in particular a four-day annual Factory Management Conference.

For its fundamental and applied work in relation to traditional and new dairy products the Institute has at its disposal the facilities of modern well-equipped laboratories. These are subdivided for administrative purposes into chemistry, engineering, and microbiology sections, although increasingly most projects involve an integration of these disciplines. Certain items of more expensive equipment, such as a computer, ultra centrifuges, mass spectrograph, and electron microscope, are shared with adjacent Divisions of the Department of Scientific and Industrial Research and Massey University. The Institute also has access to large and small animal facilities at Massey University.

Closely integrated with the laboratory is an extensive Processing Hall for the pilot-scale manufacture of traditional and new dairy products. The scale of operation of the Processing Hall, and the size and nature of the equipment installed, have been carefully selected to give maximum flexibility and integration, but at the same time to permit meaningful extrapolation of results to full-scale commercial plant. The Institute also operates well-equipped production and maintenance workshops.

From relatively small beginnings just over 40 years ago the Institute has developed into a large, well-staffed and equipped research organization capable of providing an effective scientific backing to the dairy industry. As diversification of dairy manufacture proceeds at an increasing rate, the extent to which the industry relies on the Institute must also grow. The complexity of milk and its products as basic materials for manufacture and for scientific investigation, together with the organization of the dairy industry and its progressive attitude to new ideas and new processes, makes dairy research a stimulating and exciting field in New Zealand today.

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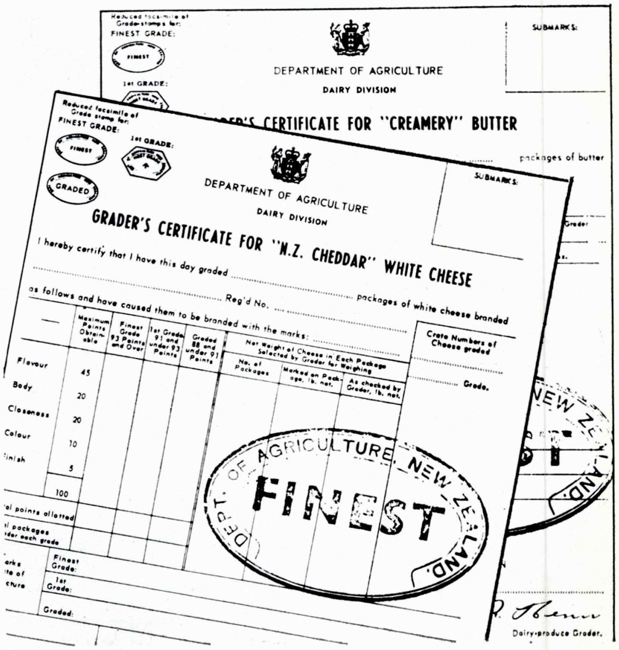
QUALITY CONTROL

By T. L. HALL
Dairy Division, Department of Agriculture, Wellington, New Zealand

Quality control of all dairy products produced in New Zealand is the responsibility of the Dairy Division of the Department of Agriculture. As an official agency, the Dairy Division is able to act impartially and quite independently of the dairy industry.

The compulsory grading of dairy produce for export became law in 1894 with the passing of the Dairy Industry Act. This provided for the appointment of dairy produce graders, the registration of dairy factories and their identification by a registered number, the control of packaging, and the establishment of cool stores at various ports where the produce could be graded and stored. Such a system had not previously been established in any country.



Reduced facsimile of Grade-stamps for:
FINEST GRADE:
FINEST
1st GRADE:

DEPARTMENT OF AGRICULTURE
DAIRY DIVISION

SUBMARKS:

ER'S CERTIFICATE FOR "CREAMERY" BUTTER

packages of butter

Grader

Dairy-produce Grader.

Reduced facsimile of Grade stamp for:
FINEST GRADE:
FINEST
1st GRADE:
GRADED

DEPARTMENT OF AGRICULTURE
DAIRY DIVISION

SUBMARKS:

GRADER'S CERTIFICATE FOR "N.Z. CHEDDAR" WHITE CHEESE

I hereby certify that I have this day graded ……………………………………
…………………………………… Reg'd No. …………………………………… packages of white cheese branded
as follows and have caused them to be branded with the marks: ……………………………………

—	Maximum Points Obtainable	Finest Grade 93 Points and Over	1st Grade 91 and under 93 Points	Graded 88 and under 91 Points	Net Weight of Cheese in Each Package Selected by Grader for Weighing: No. of Packages	Marked on Package, lb. net	As checked by Grader, lb. net
Flavour	45						
Body	20						
Closeness	20						
Colour	10						
inish	5						
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al points allotted							
l packages der each grade							

Crate Numbers of Cheese graded
…………………… Grade.

arks te of cture
Finest Grade:
1st Grade:
Graded:

DEPT. OF AGRICULTURE, NEW ZEALAND.
FINEST

The original provisions of the Act of 1894 remain basically unchanged, although amendments and additions have been made in the light of experience or as necessitated by the tremendous increase in production which has taken place.

As a very large proportion of the dairy produce that is manufactured is exported, grading takes place at 11 ports, which have been appointed to be the only ports from which dairy produce may lawfully be exported. Cool stores, usually co-operatively owned by farmers, are established at these ports, and accommodation and facilities for the Dairy Division's grading service are provided by the cool store company. Grading and clerical staff and certain equipment are provided by the Dairy Division, but all the costs of the grading service are recovered from the industry by means of a levy on produce graded or manufactured.

Until the mid-1940s the grading of dairy produce applied almost exclusively to butter and cheese, as these were the main export products. Since then, however, there has been a dramatic increase in the production of milk powders of various types, casein, lactalbumin, caseinates, whey powders, and allied products. The quality specifications for these products relate not only to their physical and compositional characteristics but also to chemical and bacteriological aspects. Therefore, in addition to the senses' evaluation of colour, odour, flavour, etc. the grader must be familiar with a variety of additional tests and analyses and with the various quality standards required in order to grade these dried products correctly.

The various analyses and tests on dairy products are carried out by chemists and microbiologists in large, well-equipped laboratories maintained or supervised by the Dairy Division. The physical examinations and senses evaluations of dairy products are carried out by the dairy produce grader, who correlates these with chemical and microbiological test results and finally allots the appropriate grade for the product. The system of grading of dairy products, which has been applied by dairy produce graders over the years with the knowledge and skill born of experience, has had two very important influences. It has enabled New Zealand to maintain a high and uniform standard of quality for her dairy produce, and this in turn has engendered confidence amongst buyers that the Grade Certificate as issued by the Dairy Division of the New Zealand Department of Agriculture is a reliable indication of quality and a sound basis on which to purchase.

Grading of Butter and Cheese

Dairy companies normally deliver these products to the grading port nearest to their manufacturing dairy. On arrival at the cool store, one box of butter from each churning and one carton of cheese in 25 from each vat are withdrawn for sampling and examination by the graders. After carefully noting such characteristics of the pro-

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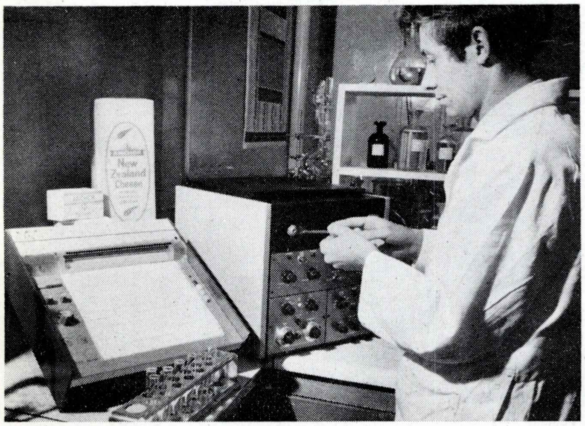
Grading butter at Auckland Grade Store. (*Barry McKay Industrial Photography, Auckland*).

duct as the colour, odour, flavour, texture, body, etc., the grader allots points to these individual features. The total points allotted determine the grade category in which the butter or cheese is placed. A maximum of 100 points is allowed, with a score of 93 points or better placing the product in the "Finest" grade category. Progressively lower pointings place the product in the "First" or "Second" grade. The grader's decision is final and only in exceptional circumstances will a re-grade be allowed.

Every sample package of butter or cheese is analysed by dairy produce testers for moisture, fat, salt content, etc. If these come within the legal requirements, the grader notifies the owner of the cool store of the grades allotted for the various consignments. It is then his responsibility to have the appropriate official grade stamp applied to all packages and to store them under certain specified conditions of temperature, and in the case of cheese, humidity, until the time of shipment. Only packages bearing the official grade stamp may be exported.

The grader then issues Grade Certificates for the produce, copies of which go to the manufacturing dairy company and to the Dairy Board. The Board then pays the dairy company for the produce, using a scale of differential payments based on the grade as indicated on the Certificate.

In addition to his inspection and quality evaluation of the product itself, the grader checks the weight of a certain percentage of the packages and examines them for general appearance, cleanliness, neatness of branding, and tidiness of wrapping. If these are satisfactory, or only partially satisfactory, the grader may reject all or part of the consignment. Alternatively, he may apply penalties by reducing the grade points allotted and therefore the payment to the manufacturer.



Chemical examination of butter and cheese in a Dairy Division Laboratory. (*Barry McKay Industrial Photography, Auckland*).

Grading of Milk Powders

A grading system for roller dried milk powder was introduced in 1949, and for spray dried powder in 1954. Production of both types of powder was increasing, but the quality was often indifferent. Standards were established, based on internationally recognized specifications, and these formed the basis for the much more stringent quality requirements of the present day. The grading of milk powder, with its emphasis on chemical and microbiological tests, as well as compositional analyses, necessitated the establishment of laboratories at the larger ports and the employment of chemists, microbiologists, and trained technicians to carry out this analytical work.

The production of spray dried milk powder in particular grew very rapidly and it was soon no longer possible to store milk powder at the ports while awaiting shipment. Since refrigerated storage was not required in this case, it was more convenient and more economical for dairy companies to provide their own storage at the factories. Under these conditions it was no longer possible for the Dairy Division to inspect all of the powder, withdraw samples and test them, or to supervise the application of the official grade stamp. A new grading system had to be devised. This provided for the dairy company to act as agent for the Dairy Division. The company has to provide a fully equipped laboratory and trained staff to run it. A qualifying period is necessary, during which the factory laboratory's results are closely checked. When the Dairy Division is satisfied that the factory laboratory is fully competent, the factory is approved by the Director of the Dairy Division for agency grading.

With this authority, the factory samples the powder at the rate of at least one in every 100 packages, carries out all the necessary test analyses, senses evaluations, etc., allocates the appropriate grade to the powder, and applies the official grade stamp to each package accordingly. Every sample is taken in duplicate, the second sample being sent to the Dairy Division laboratory, where a percentage of these samples is tested and the results compared with those supplied by the factory. Any serious inaccuracies or discrepancies can result in the factory being deprived of permission to undertake agency grading. This could result in the dairy company being involved in quite substantial additional costs for storage of produce.

An officer of the Dairy Division regularly visits the factories operating under the agency grading system to ensure that the approved procedure is being observed, and also to take a number of random samples from the milk powder in store for further comparative testing. The agency grading system for spray dried milk powder has now been operating successfully for over 15 years.

Grading of Casein

A rather different system of grading is used for casein. This product is blended at the factory in batch lots of several tons each, and composite samples of these are obtained by taking aliquot samples from the bags at the time of packing. These samples, properly identified, are sent to the Dairy Division laboratory for analyses and grading.

The quality specifications for casein are numerous and involve some tests which require special apparatus and a high degree of technical knowledge and skill. A large proportion of the casein produced in New Zealand is of the edible type, and the grading of this product involves additional tests. No factory can manufacture edible casein without prior approval of its suitability for this purpose by the Director of the Dairy Division.

Quality Standards for Dairy Products

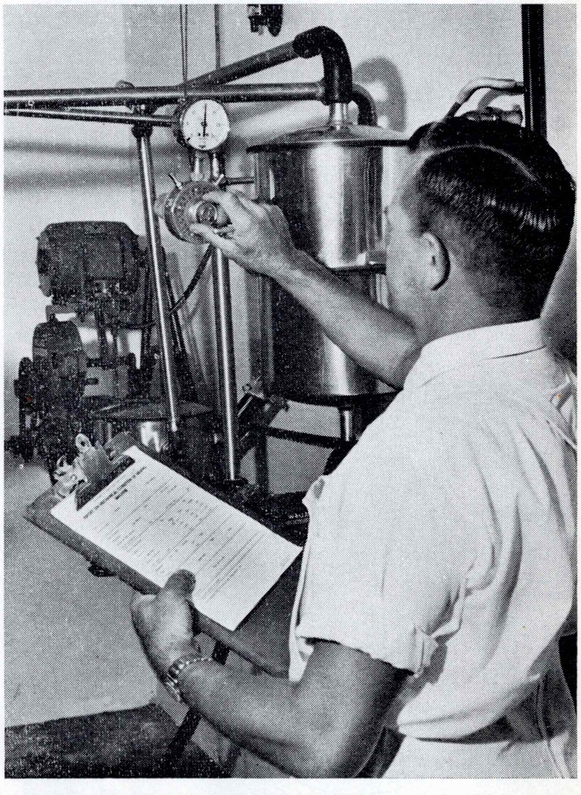
A feature of international trade in dairy products during the past few years has been the demand for much higher standards of purity and, particularly in the case of dried products, for stringent and complex specifications more appropriate as indicators of suitability for particular end uses than of quality in the accepted sense.

These new developments have not lessened the importance of the traditional quality standards which have been proved over the years in New Zealand, but have added a new dimension in which the emphasis is on laboratory analysis and control and the use of intricate test methods and sophisticated equipment. While it is possible for a limited number of the better-equipped and staffed factory laboratories to perform some of these tests, most of the work is carried out in Dairy Division laboratories. This has resulted in new laboratories being established, the appointment of additional qualified staff, and the provision of more scientific equipment.

In addition to what may be regarded as the normal grading standards of composition, physical characteristics, etc. for dairy products, the Dairy Division is now frequently, and in some instances routinely, called upon to certify that various products conform to internationally accepted standards for freedom from coliform organisms, salmonella, coagulase positive staphylococci, yeasts and moulds, copper and iron, pesticide residues, antibiotics, etc.

Related Activities

The grading of dairy products in New Zealand does not, of course, operate in isolation from the rest of the industry. It is well recognized that a product can be only as good as the raw milk from which it is produced, the equipment with which it is processed, the standard of hygiene and the technical competence of operators in the factory, and the conditions under which it is transported and stored. Accordingly, the Dairy Division operates an extensive instructional and advisory service on the farm and in the factory. The Dairy Division thus exercises a marked influence over the production of milk of good quality on the farm, and then ensures that this milk is so handled and processed in the factory that dairy products of the best possible quality are manufactured. Graders liaise very closely with instructors, so that the latter are aware from day



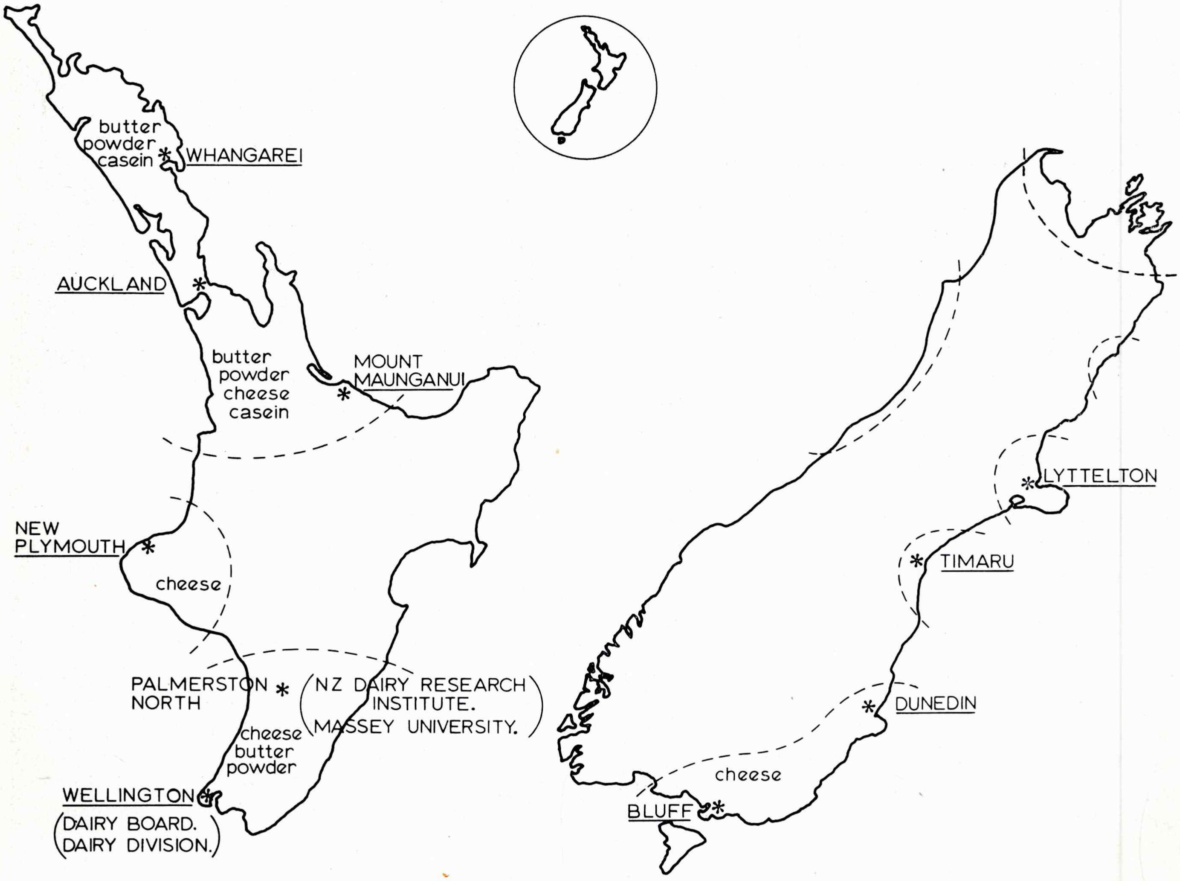
Dairy Division Farm Dairy Instructor checking milking plant. (*Ruakura Agricultural Research Centre, Hamilton*).

to day of the quality of the products being manufactured, and can immediately follow up, at the factory concerned, any defects which may become apparent in the produce.

Dairy Division officers also play an important role in the marketplace, particularly in the United Kingdom, where an office of the Division is established. Dairy Division officers in London inspect a cross-section of butter and cheese from every shipment arriving in the United Kingdom and report to New Zealand on the quality and out-run condition. Any deterioration which may have taken place in quality between the initial grading and the examination in London can then be followed up with the factory concerned.

Dairy Division officers in London maintain a close liaison with wholesale and retail distributors and with packers of dairy produce and are thus able to report any new trends or developments which may necessitate alterations or improvements to any aspect of quality, composition, or presentation of New Zealand produce. The officers also supervise the conditions under which stocks of New Zealand butter and cheese are held in the United Kingdom and carry out inspections of the hygienic and other conditions obtaining in plants where butter or cheese is being repacked into wrappers which identify the contents as being of New Zealand origin.

The final inspection of dairy produce in the marketplace thus completes the Dairy Division's supervision of quality through successive stages from milk production on the farm in New Zealand to the point of distribution overseas. It is the culmination of the work of every Dairy Division officer, which is directed in one way or another towards the achievement of a high standard of quality and purity in all New Zealand dairy products.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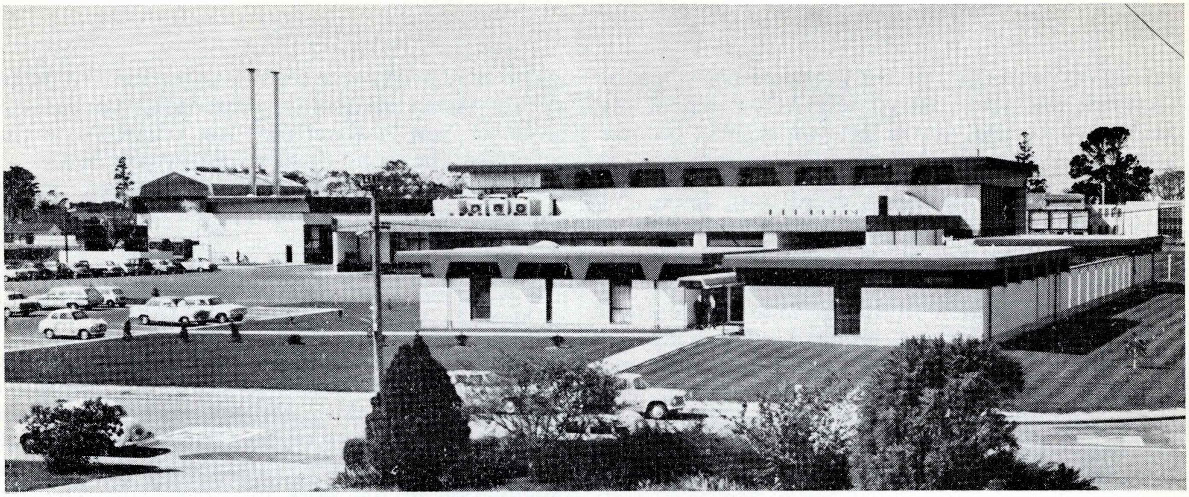
MOUNT
MAUNGANUI
NEW
PLYMOUTH
cheese
PALMERSTON
NORTH
NZ DAIRY RESEARCH
INSTITUTE.
MASSEY UNIVERSITY.
cheese
butter
powder
WELLINGTON
DAIRY BOARD.
DAIRY DIVISION.
LYTTELTON
TIMARU
DUNEDIN
cheese
BLUFF

Map showing location of Grading Ports (underlined) and principal products made in various locations.



General view of Canterbury Dairy Farmers' Milk Station, Christchurch. The administration offices are in the foreground, the main processing building immediately behind, and the boilerhouse and powder plant in the left background. (*V.C. Browne, Christchurch*).

MARKET MILK

By D. J. HENDERSON

New Zealand Milk Board, Wellington, New Zealand

Liquid milk and cream sold for home consumption account for less than 10% of all dairy production in the country and so nearly all the dairy industry is geared to the manufacturing of dairy products, primarily for export. While there is some dairy farming in most parts of the country, in the main production for manufacture is concentrated in certain well-defined districts where conditions are particularly favourable. In contrast, with the scattered nature of the population, market milk supplies must be arranged reasonably near to the market if transport costs are not to become disproportionate. Largely due to this, market milk is separately organized, although there is some overlap. Some dairy companies are also milk producer or treatment organizations, and market milk production surplus to requirements is used for manufacture.

In brief, the industry is organized into co-operative producer companies which allot quotas to their suppliers and contract with the New Zealand Milk Board to guarantee their markets. The milk needed for town supply is either pasteurized and bottled by the producer co-operative itself or sold to the pasteurization plant for the district, if it is separately owned. The bottled milk is in due course delivered daily to all householders, mainly by independent roundsmen-vendors. All prices and allowances are controlled. Town supply milk is subsidized in New Zealand so that the consumer prices are considerably lower than total costs.

National Organization

Town milk supplies are under the general supervision of the New Zealand Milk Board. The Board consists of ten members, of whom one is appointed as chairman by Government; two are nominated by the Municipal Association of New Zealand to represent consumers in cities and boroughs; one is nominated by New Zealand Counties Association to represent consumers in smaller towns and country districts; three are nominated by the Town Milk Producers Federation of New Zealand, one to represent producers in the South Island and two for the North Island; one is nominated by the Dominion Federation of Milk Vendors; one is appointed by Government to represent the interests of women and children; and one is appointed as the representative of the Government.

The objects for which the Board is established are the provision of an adequate supply of milk of good quality for human consumption and the organization of the town milk industry on an economic basis.

Detailed duties include the following:

1. The Board contracts with producer companies to supply markets, makes other detailed arrangements including quality price adjustments to ensure that all markets are fully supplied with good quality milk, carries out cost investigations for the fixation of national prices and allowances, fixes special allowances on a local basis including all cartage allowances where this may be necessary, makes financial adjustments with all those in the industry to see that they get the prices or allowances to which they are entitled, and to that end pays out subsidy on behalf of Government.
2. The Board provides any administrative services needed by the Milk Prices Authority referred to later.

3. It administers the consumer price orders made under the Milk Act 1967 and makes special local consumer price authorizations where these may be necessary.
4. It selects and licenses all milk vendors, administers distribution zoning schemes, and supervises service to the public.
5. It combines with trade organizations in the Milk Publicity Council, which is financed by contributions from the Board and trade interests, and provides the administrative services needed by it.

The Board is financed by a levy on all sales of milk and cream.

Other organizations involved on a national basis are:

The Milk Prices Authority, with representatives of the trade and Government, which fixes national treatment and distribution allowances.

The Health Department, which administers food and drug standards.

The Agricultural Department. Apart from general farm advisory services, animal health programmes, etc. which are supervised by other Divisions, the Dairy Division of the Department is responsible for the registration and inspection of farms supplying town milk and of all treatment stations and provides an advisory service in regard to these matters.

The Town Milk Producers Federation, the *Milk Treatment Station Federation* and the *Dominion Federation of Milk Vendors* represent the interests of their respective members.

District Organization

Producer Associations

Producer associations, in the main consisting of co-operative companies in which all the producers take shares, guarantee the overall supply of milk to the areas they service on a daily, year-round basis. The individual members give quota guarantees to their companies. A producer company which has demonstrated its ability to meet all the requirements of its markets may be gazetted as the Supply Association for the district concerned. Such gazetting gives the company substantial protection from competition in the district. There is very little producer-vendor milk sold outside Supply Associations in New Zealand today.

Milk Treatment Stations

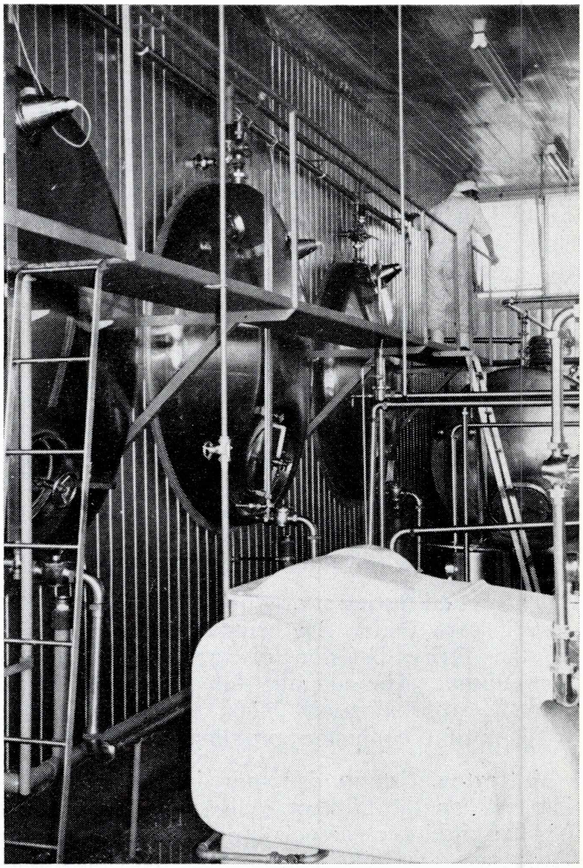
There are 47 treatment stations throughout New Zealand today under various forms of ownership and control, with throughputs ranging from 500 to about 30,000 gal daily.

Of the 47 stations 19 are owned by producer co-operative companies, 10 by co-operative dairy companies, four by local authorities, and 10 by companies in which the shareholders are combinations of the above groups — mainly producer companies and local authorities. Only four, mainly small, are entirely in the hands of private owners.

Except in the largest metropolitan districts only one milk treatment organization is authorized for each urban area or other well-defined consumption district. Where there is more than one treatment station in a district, the trade is shared on an agreed basis.

Milk Vendors

These are usually individual operators, each owning a vehicle and collecting his supplies from a treatment station or depot. There are very few large vending enterprises. All vendors are licensed by the New Zealand Milk Board and a zoning scheme is maintained under which in general there is only one vendor for each zone.



Bulk storage tanks and homogenizer at Rotorua Milk Treatment Station.

A daily delivery service to the front gate of the householder is given. Approximately 80% of all milk is delivered in this manner.

Local Authorities

Territorial local authorities, i.e. Borough Councils, City Councils, County Councils, and Town Councils, administer some local aspects of food hygiene control. They register and inspect shop dairies.

Town Milk Producer Price

This price, which is the one payable to producer companies pursuant to the supply contracts with the Board, is fixed by Government. Although it includes allowance for the added costs of milking for town supply — particularly those involved in giving a guaranteed all-the-year-round supply — it changes in a strict ratio with changes in the returns on whole milk for manufacture.

The price, which is a gallonage one, is paid out at different levels for different seasons of the year.

Collection

Practically all market milk is collected in bulk and chilling of such milk on the farms is mandatory. Practically all farm chilling complies with a standard requiring milk to be chilled to 50°F within 2½ h after commencement of milking, and to 40°F within a further hour. In most instances milk is precooled through water coolers to reduce the amount of refrigeration required in the farm tanks.

Quality

The Food and Drug Regulations 1946 require milk sold for human consumption to contain not less than 3.25% milkfat and 8.5% solids-not-fat. The milk must also last at least four hours under the methylene blue reductase test. These standards are enforced by the Department of Health, which arranges for random samples to be taken.

The actual testing procedures of milk treatment stations are under the control and supervision of the Dairy Division of the Department of Agriculture. The average fat content of town milk is approximately 4.1% and the average solids-not-fat content approximately 8.75%.

A treatment station is required to do the following tests on the milk of each supplying member of its producer association: Methylene Blue Reductase — daily, except that frequency may be reduced to 15 times per month in the months of June and July each year. Milkfat — sampled daily and tested as 10-day composites. Solids-not-fat — three times per month. Sediment — two times per month. Disc assay or brom-cresol-purple for antibiotics — three times per month. Freezing point — as necessary.

These requirements are under revision at present. The following quality payment grades are operated by the New Zealand Milk Board in conjunction with individual producer companies:

(a) Finest Grade — milk which passes a six-hour reductase test and which does not fall below 3.5% fat.

(b) First Grade — milk which passes a four-hour reductase test, but fails to pass the six-hour test and/or which contains 3.25% fat, but not 3.5%.

(c) Second Grade — milk which fails to pass a four-hour reductase test and/or contains less than 3.25% fat.

The grading is done on a basis of treatment station testing. The First grade is the basic grade and a premium of 16.7 cents per gal is given for Finest grade, and a deduction of 3.34 cents per gal made for second grade. Over 98% of all milk handled by treatment stations satisfies the standards for Finest grade milk.

Producer companies are required to make certain deductions from payouts to individual suppliers when milk fails on the other tests.

Treatment and Packaging

Pasteurization by the H.T.S.T. method is almost universal. Normal pasteurized milk is not standardized. However, most of the larger treatment stations also supply homogenized milk which is standardized to a 3.3% fat content. Sales of this product seldom account for more than 10% of a treatment station's total sales of milk. There is no sale of sterilized or ultra high temperature treated milk in New Zealand.

Glass bottles are, for all practical purposes, the standard containers for milk and cream sold for human consumption in New Zealand. A bottle having a neck of 38mm diameter and sealed with aluminium foil, and inter-changeable between treatment stations, is used. The aluminium foil caps must carry on them, usually embossed, the identity of the product, the name of the processing treatment station and a number which indicates the day of bottling or the day thereafter.

Most stations have standardized on the pint bottle for milk, although a few stations also use quart bottles. Larger glass containers are not used. Adoption of metric sizes is under examination at the present time. Milk vendors, and in most cases the consumers, are charged with the cost of bottles not returned, and this keeps down bottle wastage. Average bottle trippages of 100 or more are fairly normal.

Very little use is made of cartons, principally because of the added costs.

Cream and By-Products

Cream is handled as an adjunct to the town milk supply. There is only one grade of cream sold and it is required to have a minimum fat content of 40%. It is mainly sold in half-pint bottles.

Most of the large treatment stations also manufacture such products as yoghurt and cottage cheese. Within the last few years the increase in the sale of yoghurt, particularly full fruit flavour varieties, has been particularly high.

General

The following statistics relative to the town milk industry are based mainly on figures for the year ended 31 August 1969:

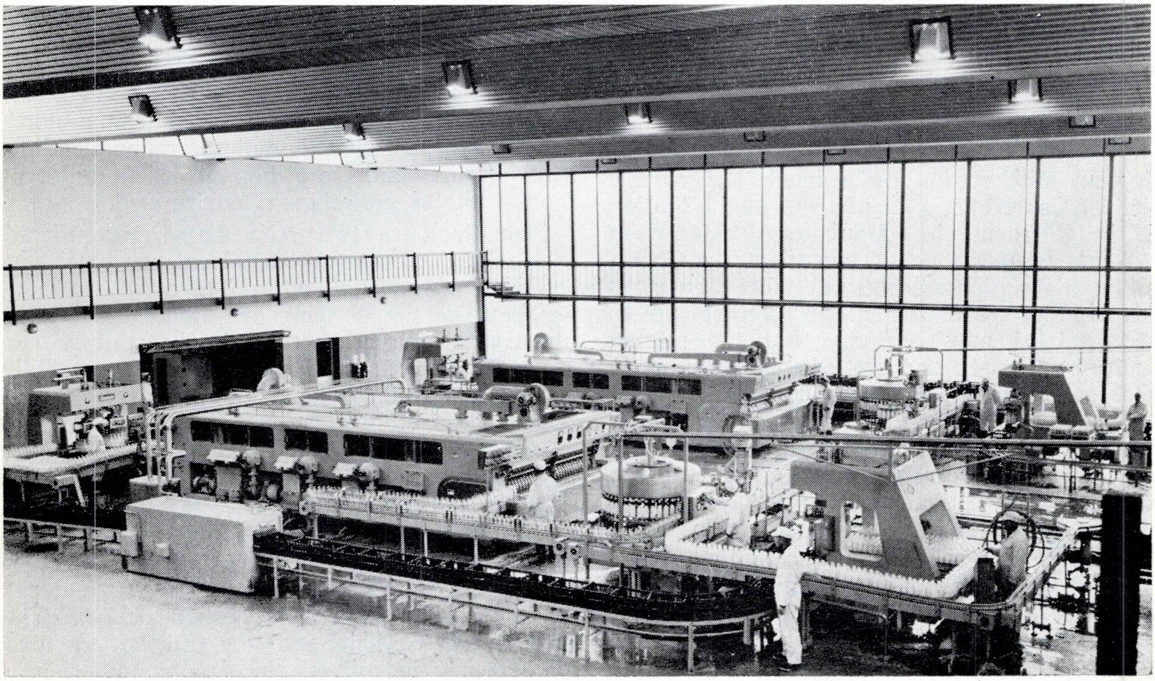
Total town milk sales	77,585,000 gal
Total cream sales	1,624,000 gal
Milk consumption per head	30.97 gal per annum
Cream consumption per head	5.29 pints per annum
Average producer price for Finest Grade Milk (year ended 31 August 1970)	25.174 cents per gal
Principal allowances:	
Pasteurization (for all except small treatment stations)	3.24 cents per gal
Bottling	3.47 cents per gal
Distribution (Home delivery under 2 gal)	13.11 cents per gal
Standard consumer price of milk	4 cents per pint
Average level of subsidy	2.1 cents per pint
Retail home delivered price of cream	16 cents per half pint

Treatment Stations

This review concludes with a description of two individual treatment plants.

Rotorua

A modern milk station, likely to be seen by many overseas dairying visitors to New Zealand, is operated by the Rotorua Milk Treatment Co. Ltd., a co-operative producer company, and it can be taken as an example of the facilities which are provided to service secondary cities. It is the only station in Rotorua (population 37,000) and the demand for bottled milk, pasteurized or homogenized, is 3,800 gal per day, rising to a peak of 5,000 gal per day during the Christmas and New Year period (Rotorua is a holiday centre). An average of 70 gal of cream per day



View of bottle washing and filling lines, Canterbury Dairy Farmers' Milk Station, Christchurch.

is also handled. The company markets yoghurt but does not otherwise manufacture dairy products, nor does it operate milk rounds.

The station was opened in 1968 and is thoroughly modern in every way. The building itself is a fairly orthodox one, basically of rectangular shape, with pasteurizing equipment on a mezzanine floor above the coolroom, with the main bottle washing and bottling hall running the height of the building, and with a basement and service tunnel underneath. The capacity of the cool store is 8,000 cu. ft. Milk storage tanks, insulated and refrigerated, are housed outside the building with only the ends projecting through the wall to the pasteurizing section. Special features include cladding of the entire ceiling and a considerable proportion of the walls of the bottling hall and the processing section with embossed stainless steel, and the use of vinyl sheathing on some of the wall surfaces and on the floor of the bottling area. All free edges of the vinyl are either welded or fused so that a completely unbroken surface results. Stainless steel chequer plate flooring has been used in the area housing processing equipment.

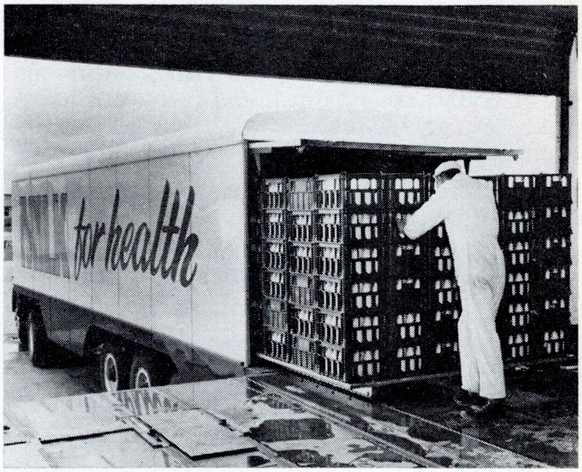
Plant includes a 1,500 gal per hour Paasch-Silkeborg pasteurizer, a 1,000 gal per hour A.P.V. Manton-Gaulin homogenizer, and a 12,000 bottles per hour Dawson bottling line comprising crate unstacker, bottle decrater, Durus single and power soaker and hydro-washer, Dawson-Berner filler and capper, bottle decrater and crate stacker. Heat requirements are met by a hot water ring mains fully automatic Allen Ygnis oil-fired boiler, with a primary circuit at 220°F and a secondary wash-water circuit at 180°F.

Christchurch

A new milk station on a much larger scale is that of Canterbury Dairy Farmers Milk Station Ltd. in Christchurch (population 260,000), in the South Island. One of two plants in Christchurch, this station opened in 1969. The plant is capable of pasteurizing and bottling up to 40,000 gal of milk per day, but the present quantity pasteurized and bottled is approximately 22,500 gal of milk, and an average of 500 gal of cream, per day. At the peak of the season it handles about 13,000 gal of surplus milk per day. The surplus milk is separated and the cream despatched to a butter factory and roller dried powder made from the skim milk.

The company, which is a producer co-operative, collects all the milk from its members in its own tankers. It has a limited amount of wholesale delivery trade, but mainly supplies individual vendors, either directly from the main station or from depots.

The company has an eight-acre site only four miles from the centre of Christchurch. The main building includes a processing and bottling hall with a floor space of 12,600 sq. ft. In the same building are an extensive reception area for empty bottles, cool room, tanker reception and cleaning area, bulk storage, facilities for cultured milk products, modern laboratory, and factory administration offices. A basement floor below of 18,000 sq. ft houses electrical and refrigeration equipment and other services, and also includes two 150,000 gal concrete chilled water tanks. Separate buildings on the site provide for the boiler house and for milk powder drying, for garage and vehicle maintenance, for company administration offices, and for a staff cafeteria.



Loading cargon transporter, Canterbury Dairy Farmers' Milk Station. (*V.C. Browne, Chrstchurch*).

The lower walls and floor of the processing and bottling hall are covered with vinyl, the ceiling is corrugated aluminium and the north wall is sheathed with aluminium arcline cladding. Milk storage tanks are housed in an adjacent room with the entire room refrigerated.

Plant includes two Alfa Laval pasteurizers, each with a capacity of 3,500 gal per hour, one equipped with a clarifixator. There are two independent Dawson washing and filling lines, complete with automatic decrating, recrating, etc. Each line handles 24,000 bottles per hour. Fully automated product flow and in-place-cleaning equipment is supplied by A.P.V.

A feature of the station is the cargon system for handling crated bottles. The cargon decks, each capable of taking 180 crates with a gross laden weight of about 4¼ tons, run on rails right through the factory from the empty bottle reception end to the coolroom and to despatch docks for milk being sent to suburban depots. The cargon rails continue into the transporters used for carrying the milk to the depots, and when a transporter is backed into the dock and linked up, the full load of 1,800 gal can be loaded by one man in approximately 3 min.

DAIRY TECHNOLOGY EDUCATION IN NEW ZEALAND

By J. H. HENSON and J. K. SCOTT

Massey University, Palmerston North, New Zealand

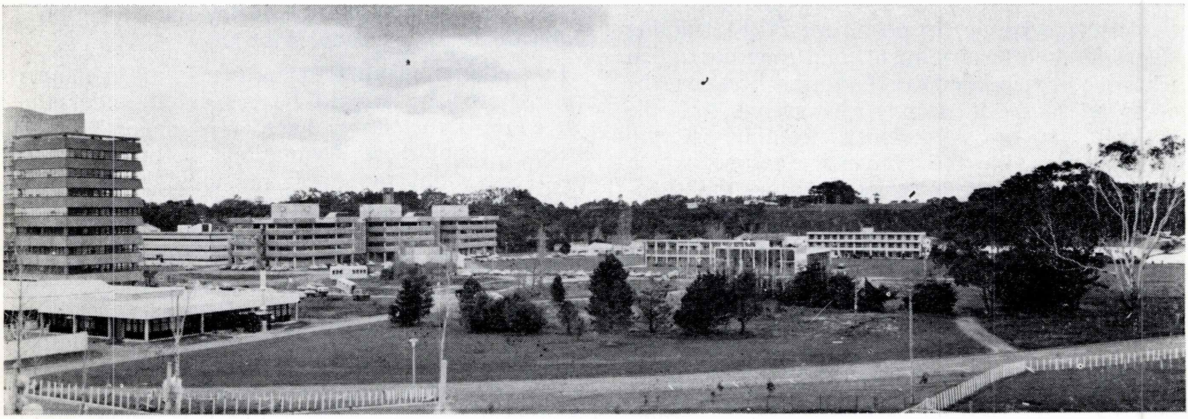
Formal training for the staff of New Zealand dairy factories was initiated in 1928 when what is now Massey University was established as an agricultural college following the amalgamation of schools of agriculture in Auckland and Wellington. Massey Agricultural College from its inception offered courses leading to the degrees of Bachelor and Master of Agricultural Science of the University of New Zealand and, in addition, taught a variety of shorter courses in agriculture for which College Diplomas or Certificates were awarded. In general these courses were orientated towards farming, with the degree courses providing professional training for those intending to enter advisory services and research, and the diploma courses for those who intended to take up farming on their own account.

In the planning of Massey Agricultural College, provision was made for accommodating on the campus the newly created Dairy Research Institute. This close association between the two institutions provided an ideal combination of staff and material resources on which to build courses of instruction in dairy technology. Accordingly, a dairy science option was built into the Agricultural Science degree, and a dairy manufacturing diploma course was established to meet the growing needs of the dairy factories for trained staff.

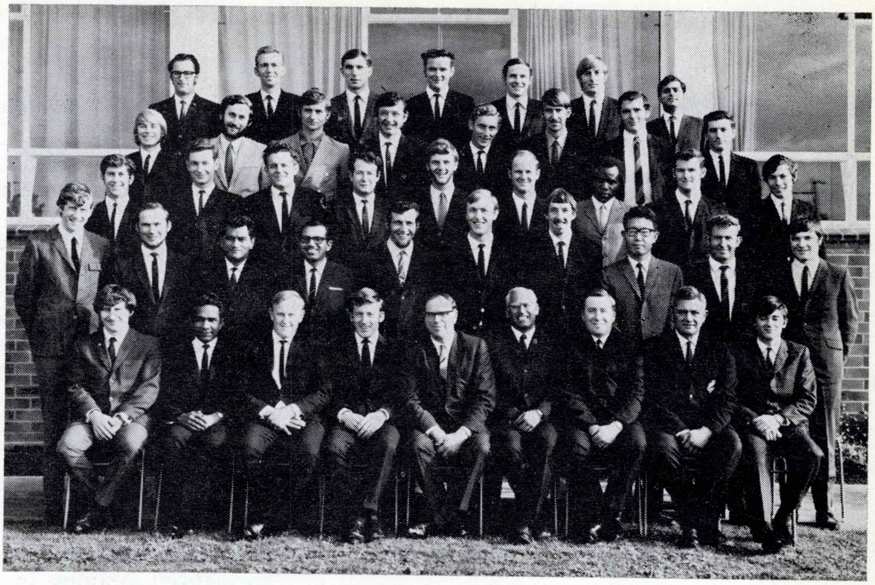
Diploma Training

Because of the highly seasonal nature of dairy production in New Zealand, the dairy course was organized as, and has remained, a winter course designed to fit the labour requirements of the industry with minimum disruption. On the basis of three successive terms of approximately three months each, the Diploma in Dairying course was first offered in 1928, and from its inception has been the principal form of training for staff of New Zealand dairy companies, as well as providing for a steady flow of overseas students.

Initially the course was organized to provide specialized options in buttermaking and cheesemaking, since butter and cheese production constituted practically the entire function of New Zealand dairy factories. Later a town milk option was added. Subsequently, as the dairy industry became more diversified, the option system threatened to fragment the course excessively, and the options were withdrawn in favour of a broader, more generalized training in the various products (Henson, 1966). At the same time, as the demand for factory laboratory services grew, a laboratory practice option was introduced into the Diploma course. The title of the Diploma was also changed to 'Diploma in Dairy Technology'.



A general view of the Massey University campus. The Food Technology building is centre foreground. (*Massey Photographic Unit*).



Final-year students in the 1970 Massey University Diploma in Dairy Technology course. The Director of Diploma in Dairy Technology, Mr J.H. Henson, is seated in the middle of the front row. (*Elmar Studios Ltd, Palmerston North*).

Entry standards for the Diploma have never been rigid, but full regard has always been paid to maintaining a satisfactory level to protect the quality of the award. Short of the imposition of some objective pre-entry qualifications such as University Entrance, which is not a requirement, the entry standards are necessarily subjective. However, mainly through the Dairy Industry Bursary Scheme, a screening system, based on the combination of academic and personal qualities, has been evolved and this is functioning satisfactorily. Recent amendments to the entry requirements make it mandatory for prospective students to attain a reasonable level of competence in mathematics and general science before they can be accepted into the course.

One special feature of the Diploma course is the insistence on a period of practical training in factories before enrolment, and then continued work in commercial dairy factories between the successive stages of study. This means that the practical side of a student's training is well catered for outside the University course, which consequently can be concentrated on the theoretical aspects of his training. The course then progresses from first year, which is predominantly basic sciences, through applied sciences in the second year, to the final year, which aims to co-ordinate the applied sciences into the technology of the manufacture and quality control of dairy products, and the efficient organization of a dairy company.

Originally, and for a long period, students taking the Diploma course were required to finance themselves. Ultimately, the dairy industry, through the New Zealand Dairy Board, decided to directly support the training of technologists by the institution of bursaries at degree and Diploma levels. Government aid was also provided by way of a subsidy. At present, 50 new Dairy Diploma bursaries are available each year and are tenable for the duration of the course. The bursary scheme is a generous one and bursars receive their university fees and boarding allowance and in addition, while attending university, receive the basic wages they would be paid if working in a dairy factory. The New Zealand Milk Board operates a similar scheme on behalf of the town milk industry and awards two or three new bursaries each year. Selection of bursars is by central committees, following screening tests and personal interviews by district panels composed of dairy industry and educational representatives (Henson, 1966).

In the dairy manufacturing sector, all managers are required by law to be registered under the provision of the 'Dairy Factory Managers' Regulation'. Under these Regulations, before applying for registration, the applicant must have either passed an examination in the appropriate product, conducted by the Board's examiners, or be the holder of a Massey Diploma in Dairy Technology or equivalent qualification. A feature of the Diploma with special appeal to prospective factory managers is that, because of the broad nature of the training in dairy products, the Managers' Registration Board accepts the Diploma as the theoretical portion of its stipulated requirements for whatever category of product the applicant seeks registration. For those who are unable to attend the Diploma course and who are thus required to sit the Registration Board's examination, courses in the individual dairy products are offered by the New Zealand Technical Correspondence Institute.

Over the years the total number of diplomates has grown to about 700, including about 10% from overseas, particularly from India. Many of the New Zealand diplomates are now managing factories or are employed in responsible supporting positions, such as the Dairy Board, the Dairy Division, or the Dairy Research Institute, while an increasing number are filling key subordinate positions in other branches of the food industry for which no specialized training is available in this country.

Degree and Post-Graduate Diploma Courses

From 1961 the specialized degree in dairy technology was phased out and replaced by degrees in technology intended to meet the broader requirements of food industries in general. The four-year Bachelor of Technology degree includes general instructional programmes, closely allied to the specific requirements of graduate dairy technologists. Course work in dairy industry subjects is compulsory for one stream of food technology students taking the B. Tech. degree and is optional for the other stream. However, B. Tech. graduates wishing to specialize in dairy technology are advised to take the special one-year programme in the Massey University post-graduate Diploma in Technology, which can comprise dairy industry studies, and a dairy research project, which can be conducted within a commercial dairy factory or a milk treatment plant.

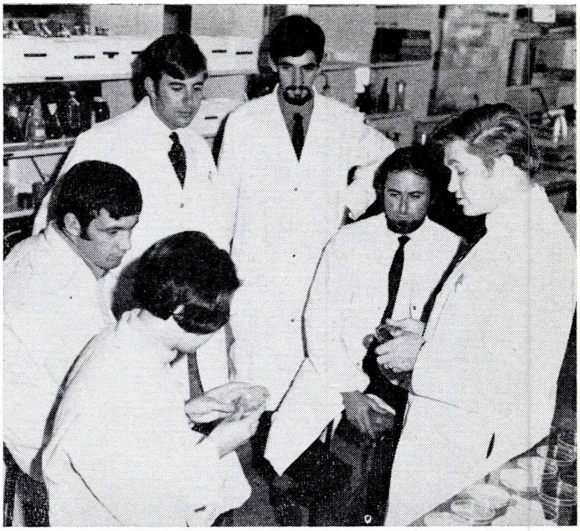
The Bachelor of Technology course (options in Food Technology, Biotechnology, or Industrial Management), followed by the post-graduate Diploma in Technology to give specialized orientation, is unique in New Zealand. Essentially, it provides a five-year period of instruction covering basic science, processing, management, and dairy technology. The most useful technology study on which to build specialized dairy industry courses is the Food Technology option of the B. Tech. degree. This option comprises a common core of food science (chemistry, microbiology, mathematics, etc.), and food processing. Students may then take either economics, marketing and product development, or food engineering and management (Scott, 1964).

A one-year post-graduate Diploma in Dairy Engineering is also available for graduates in engineering who wish to obtain specialized studies suitable for the application of chemical engineering or mechanical engineering to dairy industry practice.

Instead of taking the horizontal diploma course, B. Tech. graduates who pass with Honours may take the $1\frac{1}{2}$ to 2-year Master of Technology courses. Bursaries are available for the post-graduate Diploma and the Masterate courses.

Post-Graduate Training

The need for graduates in a wide variety of disciplines, including science (chemistry, microbiology, biochemistry, mathematics, physics), engineering (chemical and mechanical), food technology, and home science, has recently been recognized by the dairy industry, with the establishment of a Graduate Training Programme (McGillivray, 1969). This 12-month programme, which is supported by generous bursary arrangements, is available to graduates in suitable disciplines, and is designed primarily to bridge the gap between the trainee's university course and the immediate requirements of the dairy industry.



Dairy Industry Graduate Trainees discussing results of an experiment with a member of the staff of the Microbiology Department at the Dairy Research Institute. (*C. Rofe, N.Z. Dairy Research Institute*).

The course is conducted mainly at the Dairy Research Institute with the support and active participation of officers of the Dairy Board and Dairy Division and staffs of individual dairy companies. In general terms, all trainees go through a similar type of training, but account is taken of their initial degree and experience in the dairy industry, and in the latter stages the emphasis changes, depending on the type of employment which the trainee intends to take up.

In the initial stages of the course the facilities of the Institute's Processing Hall are used for training in the basic principles of all the processing operations associated with the manufacture of traditional and new dairy products. Here the aim is not to turn out competent plant operators, but to give a clear background knowledge of how dairy plant operates, of what is involved in normal dairy manufacture, of the controls that the operator has over the process and how he can use them, of the problems that occur and how they can be overcome, etc. One important aspect of this practical training is to give the trainee confidence in handling the sort of plant which is common to most dairy manufacturing operations.

Associated with this practical work is training in laboratory techniques related to quality control, in the interpretation of results of chemical and microbiological examinations of raw materials and products, and in relating these back to plant operations. The trainees also receive a theoretical training designed to familiarize them with the dairy industry and to extend their basic university training to cover the more applied aspects of dairy manufacture. In the latter stages of their course the trainees become involved in applied research and development projects, and gradually pass from the control of the Institute to that of their ultimate employer in the dairy industry.

Currently, five trainees (two graduates in science, two in chemical engineering, and one in food technology) are in the latter stages of a course at the Institute.

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SOCIETY OF DAIRY SCIENCE AND TECHNOLOGY

By B. E. DAVIES
Rangitaiki Plains Dairy Company, Edgecumbe, New Zealand

The New Zealand Society of Dairy Technology was formed in 1963 with the aim of providing a forum for those serving the New Zealand dairy industry and as a means of disseminating information through all levels of the industry. Membership in the new Society grew rapidly until in 1966 total membership stood at 484 in seven district Branches. At this time the Society started to publish its own technical journal containing research papers and general industry information.

In 1969 the Society initiated its Travelling Scholarship Scheme to provide an opportunity for younger members of the industry to view some of the wider aspects of the industry in New Zealand. The Society's Education Officer was also appointed that year and the first Society short courses were organized.

A revision of the Constitution was undertaken in 1969 as a prelude to amalgamation of the Society and the Dairy Science Association to form the New Zealand Society of Dairy Science and Technology. Current membership exceeds 800.

Present Functions of the Society

The Society now comprises nine district Branches and one National Section. The Branches organize regional activities which include meetings, visits, field days, symposia, educational courses, and social events.

National sections are intended to cater for the needs of various professional groups within the New Zealand dairy industry. The first National Section, formed from the original Dairy Science Association, fulfills the needs of dairy scientists. Its activities include conferences, educational forums on various scientific questions, and representations on various industry committees.

The Society has become involved in education, particularly in the education of factory staff at the operator level. The Education Officer has prepared a number of short courses which are run in the branch areas at the request of the district Branches. The district Branches are responsible for the organization of the courses while the Education Officer is responsible for the content. This scheme has proved a success, with some 340 industry personnel participating in the first 12 months of operation.

The Society holds an Annual Conference which rotates between the main dairying centres within New Zealand. The Conference deals with technical subjects, industry, and Society matters.

In 1970, in addition to the Travelling Scholarship within New Zealand, the Society awarded a Travelling Scholarship for attendance at the International Dairy Congress in Sydney.

Mr B. E. DAVIES
President, 1970

The Society's Journal provides a medium for the publication of research and related technical papers. It is the only vehicle for such material in New Zealand and is serving a valuable function in keeping members advised of developments in dairy technology. It is subscribed to by many libraries and individual dairy scientists overseas.

Each year nominations are considered for the Society's Distinguished Service Award. This award is granted for exceptional service to the industry and takes the form of a citation, a certificate, and a stylized statuette of a cow.

The Structure of the Society

The activities of the Society are co-ordinated by a Council which comprises elected officers and representatives appointed by district Branches and the National Section. The Journal Editor and Journal Business Manager are ex-officio Council members.

District Branches have a great degree of autonomy and are free to organize their own activities within the broad objects of the Society. Branches also organize, on behalf of Council, the Society's Annual Conference and they share responsibility for the organization of the Travelling Scholarship.

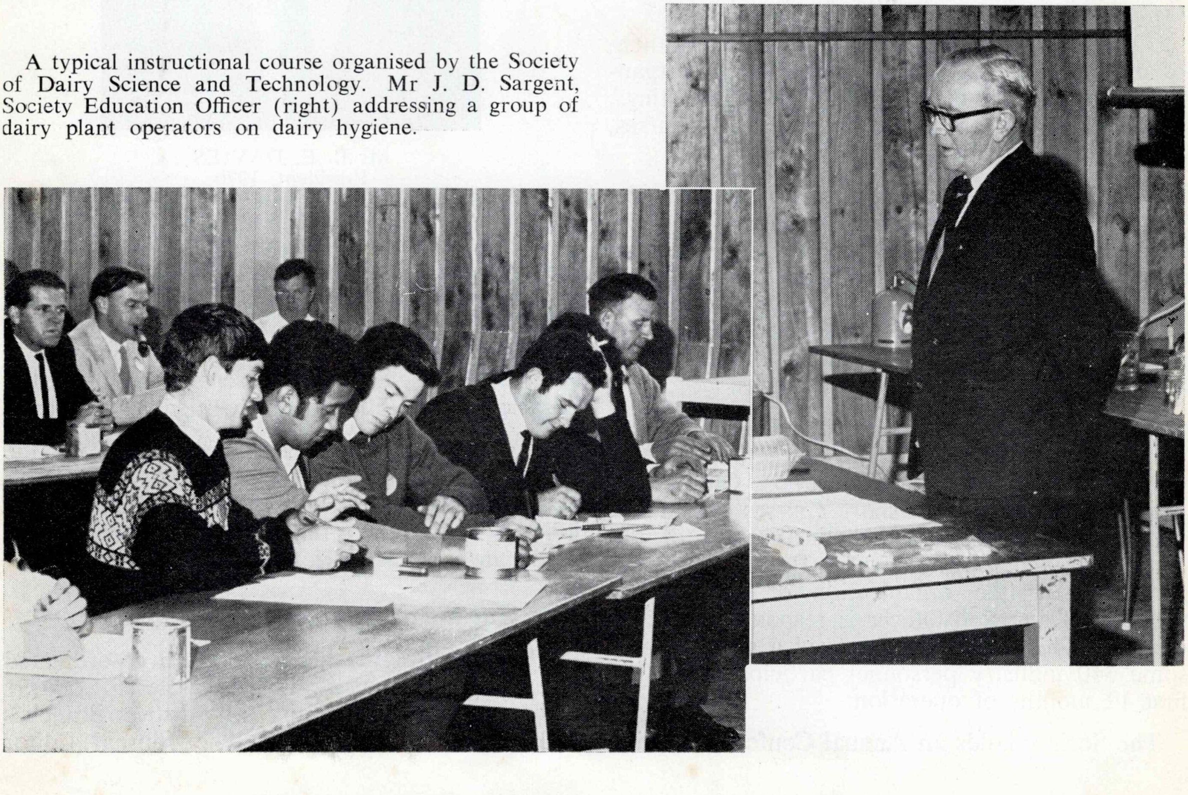
Each year Council allocates funds to Branches on the basis of a basic grant plus additional grants proportional to membership. These funds are normally adequate to cover all administrative costs and the costs of providing speakers and meeting facilities.

Integration of the Society with the New Zealand Dairy Industry

From the outset the Society has been highly integrated with the industry. There is naturally a strong representation of industry personnel on the Society's Council, and the whole purpose of the Society has been aimed at education and the dissemination of information through all facets and levels of the industry to its ultimate benefit. Nevertheless, the Society is independent from other groups and bodies and is free to develop its own opinions and to express them when necessary. A spirit of close co-operation has developed between the Society and the industry because of kindred interests.

Conclusion

The New Zealand Society of Dairy Science and Technology is closely integrated with the dairy industry and is the only scientific and technical group covering all interests in the dairy industry. It is active in all fields involving education and dissemination of technical and scientific knowledge.



A typical instructional course organised by the Society of Dairy Science and Technology. Mr J. D. Sargent, Society Education Officer (right) addressing a group of dairy plant operators on dairy hygiene.

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